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Nursery & Market Garden Industries' -- Development Society, Limited. --

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Introduction.

THE work of the Experimental and Research Station, which was commenced in 1914 under the auspices of the Nursery and Market Garden Industries' Development Society, Ltd., continues to make good progress, and is extending in many new directions. The number of inquiries and problems submitted for investigation is still increasing, and contact with growers is becoming closer every year. It is a pleasure to record that growers have made good use of the services of the Extension Officer, and from letters received it is obvious that they have appreciated his assistance. To prevent any disappointment in future it is desirable that growers who wish Mr. Orchard to visit their nurseries should make application in good time.

Membership of the Society, under whose auspices the experiments are conducted, is open to all growers and interested persons. Subscriptions are payable at the rate of two guineas for each acre of glass cultivated by the subscriber ; in return members receive future publications and any advice which is available. Members continue to be enrolled, but many more are needed, both to provide additional funds for research and to obtain complete co-operation in controlling the various pests and diseases common to glasshouse plants. Serious outbreaks over a wide area must be fought by all growers ; isolated attempts to control disease are almost bound to fail.

The latest extension to the laboratories was completed last April, and was formally opened on Monday, July 25th, by Brig.-Gen. Viscount Hampden, K.C.B., C.M.G., J.P. There was a good attendance of growers and others at the luncheon in the Halsey Masonic Hall. Mrs. Bewley, the wife of the Director, presented Lord Hampden with the golden key, and after the opening ceremony the visitors inspected the laboratories and experimental houses, where the work of the various departments was demonstrated.

The original buildings, consisting of two laboratories and an office, were erected in 1914. These were extended in 1925, at a cost of £5,400, when four laboratories, a dark room, a demonstration room, and a new office were added. Of this sum £3,100 was generously provided by the Ministry of Agriculture.

Additions to the Staff during recent years and the increase in the number of investigations the Station is called upon to undertake, made the first extension quite inadequate, and plans were prepared to erect an additional building if the necessary funds could be obtained. The total cost was estimated at £8,100, of which the Station Committee was asked to raise £1,900. This proved unobtainable and it was reluctantly decided to curtail the extension and reduce the cost to £4,200, of which 75% was provided by the Ministry of Agriculture. The remaining sum of £1,050 has been contributed by business firms and private donors, to whom our grateful thanks are offered.

The Architect, Major H. P. G. Maule, F.R.I.B.A., and the Builders, Messrs. William Bell & Sons, of Saffron Walden, are to be congratulated on providing an excellent building which has increased the accommodation by five laboratories, two offices, Director's room, library and balance room. The sum available has not permitted the buildings to be fully furnished and equipped, but the increased accommodation has added greatly to the working efficiency.

Endowment Fund.

An Endowment Fund has been opened to receive contributions from those who desire to further the work of the Station. The capital will be invested in Trustees and the interest only will be used for (*a*) future development, (*b*) repayment of debt.

Major E. J. Monro and Mr. H. O. Larsen have kindly consented to act as Trustees, and any expenditure can only be incurred with their sanction. A third Trustee has still to be appointed.

Evening Discussions.

The evening lectures for nursery owners and employees, commenced in 1925 at the request of the workers, were continued, the subjects selected being as follows :—

1931.

Dec. 14th.—Plants in their Natural Homes. Mr. P. H. Williams, B.Sc.

1932.

Jan. 11th.—Submerged Combustion. Mr. C. Featherstone Hammond.

Jan. 25th.—The Disposal of Sewage. Mr. W. H. Read, M.Sc., A.I.C.

Feb. 8th.—The Propagation of Plants. Mr. O. B. Orchard.

Feb. 22nd.—A Night with Photography. Mr. B. D. Bolas and others.

Our grateful thanks are due to the Lea Valley Growers' Association who so kindly provided a grant to cover the cost of hiring the lecture room and supplying light refreshments each evening.

Current Investigations.

Manurial and crop management trials with tomatoes have been continued. The experiments relating to the relative effects of different nitrogenous fertilisers were continued after steaming the soil during the preceding autumn. As growth was remarkably good, no further addition of nitrogenous fertilisers was made and the results obtained are indicative of the effect produced by steaming plots previously treated with different nitrogenous fertilisers. They suggest that steaming so affects the soil that the previous differences due to the different compounds are annulled.

An experiment was begun whereby the young plants were set out in trenches, which were later filled up with composts of different kinds. Wireworm injury resulted from the use of fresh turf, and the greatest improvement

in root development was observed where the trenches were filled with a compost consisting of half peat and half soil. The experiment will be repeated.

Experiments in connection with soil improvement by the addition of such materials as peat, straw, spent hops, and chrysanthemum roots were continued.

While the crop was increased by these treatments, the improvement was not so great as in the previous season, with the exception of spent hops which raised the crop some 25%.

The value of such treatments has been proved on certain commercial nurseries, especially those on heavy soils, and the work will be continued.

Some evidence was also obtained to suggest that the reduction in yield which accompanies the cultivation of the tomato in the same soil in successive years is due to some factor which the tomato leaves behind in the soil, rather than the removal of some important nutrient.

The liming experiments which have been in progress for five years indicated again that the value of lime to tomato soils has been overestimated, except where its addition is necessary to improve the physical condition.

The variety trials included a number of new crosses, but with the exception of those specially resistant to Leaf Mould none was outstanding. The resistant types showed considerable improvement in quality of the crop over previous generations.

The oil fuel experiment was continued, and once again excellent temperature control was obtained. Owing to the number of pipes in the houses being insufficient it is not possible to provide particulars of running costs. Additional pipes have been installed and it is hoped to obtain accurate data next season.

The cucumber experiments were designed to determine the effect of raising at night the bed temperature by some 15°F. This was done by laying on top of the base and immediately beneath the beds a series of wires which were heated electrically.

The results indicated that the weight of the cucumber crop is to some extent dependent upon the temperature of the compost in which the plants are growing.

Where the base was sterilized by steam, and baked soil used for making up the bed, the crop increase was of the order of 10% only, but in the case of heated unsterilized soil the increase amounted to 33%. The weight of crop produced, however, was slightly higher in the case of the heated and sterilized plots than it was when the soil was heated but not sterilized.

These results raise several interesting points for they appear to suggest that the injurious influences present in the cucumber soil can either be prevented by steam sterilization before making up the beds or by maintaining a bed temperature about 15°F. above the normal.

As in previous years, a catch crop of lettuce was grown during the winter in the tomato houses. The experiment was conducted on a large scale, and proved that this crop can be grown successfully by the methods recommended.

Work on the improvement of existing varieties has been commenced with the object of raising strains which will "heart" well during the winter period. Promising results have been obtained.

The Red Spider investigations have been continued. A sulphonated oil product was tested as a means of controlling this pest on tomatoes, and while complete control of the mite was obtained at a dilution of 1 part in 250 parts of water, its tendency to cause *œdema* gave it no advantage over the oil emulsions already in use.

An unsuccessful attempt was also made to render the tomato plant more resistant to attack by feeding with certain compounds. Treatment with salts of sodium, barium, magnesium and manganese applied to the soil have shown that an increase rather than a decrease in the feeding of the mite upon the foliage takes place after such application.

The breeding and distribution of the White Fly parasite, *Encarsia formosa*, Gehan, has been continued as in previous years. The demand for this parasite continues.

Work on the larvæ of the Cucumber Root Flies has shown that one of the most important of these, *Sciara auripila*, Winn., is brought into cucumber houses in the turf used for making up the beds. Attacks upon pot plants, in the propagation house, appear to result from these plants being kept under the same roof as the beds, which are planted at a later date.

The larvæ caused serious danger on several nurseries early in the year.

Previously a soil drench of mercuric chloride at a concentration of 1 in 1,000 applied to mature plants had given promising results, but early this year it was found to be unsuitable for young plants as it caused severe hardening. Many new substances were tested and it was found that a compound consisting of nicotine in a sulphonated oil gave complete control of the maggot at a strength of 1 in 500 and could be used at all stages of plant growth.

Investigations in relation to Woodlice are in progress for the purpose of discovering a substitute for Paris Green in baits used for destroying these animals. Dried blood is being employed as a medium for distributing substances poisonous to Woodlice.

Thrips constitute an important pest or many glasshouse plants, and it has been shown, by breeding specimens under isolated conditions, that the glasshouse Rose Thrips (*Thrips fuscipennis*, Hal.) is a species quite distinct from the outdoor Rose Thrips (*Thrips major*, Uzel). Structural characters have now been found by which the females of the two insects can be separated with ease and certainty.

A dust containing naphthalene, lime and nicotine has proved effective in destroying the Onion Thrips (*Thrips tabaci*, Lind), a pest of cucumber, arum, cyclamen, and carnation plants. Experiments with this dust upon the Rose Thrips are at present incomplete. It has proved effective as a control for the hot house Thrips (*Helio-thrips femoralis*, Rent).

The mixture of salicylanilide and agral 1 has been used widely on nurseries for the purpose of controlling Leaf Mould (*Cladosporium fulvum*). When applied as soon as the disease makes its appearance good results have been obtained.

When used as a means of controlling powdery mildew of the cucumber, a slight scorching of the foliage was observed on young plants, but this was overcome by replacing agral 1 by agral N. Agral N. is more concentrated than agral 1, and only half the quantity should be used.

A spray mixture consisting of $\frac{1}{8}$-oz. shirlan paste (salicylanilide) and $\frac{1}{8}$-oz. agral N. in 1 gallon of water has been widely used with success as a means of controlling this disease.

A great deal of attention has been given to a disease of the chrysanthemum which has been named "leafy gall." The disease is infectious. It affects the young growths which spring from the base of the flowering stems, and which should provide cuttings for the following season. An affected shoot branches repeatedly to form a dense mass of short, thickened shoots with small distorted leaves, and when the disease is severe it is difficult to obtain an adequate supply of cuttings. A bacterium has been isolated which produces swellings in the stems of chrysanthemums and tomato plants, but the precise symptoms of "leafy gall" have not yet been produced by inoculation. In culture, the organism resembles closely the "crown gall" organism, *Bacterium tumefaciens*.

Preliminary experiments with a view to prevention and control have been carried out, and observations concerning the susceptibility of varieties and the history of gall formation have been made.

The investigation of virus diseases have been continued. Further work on the effect of the virus of aucuba mosaic on the metabolism of the tomato plant has shown that there is a slight increase in the starch content of the infected plants shortly after inoculation, followed by a marked decrease as compared with healthy plants. The decrease is most pronounced under conditions of high

light intensity. The amounts of reducing and non-reducing sugars also show variations which are most marked in the decrease of sugars after twelve hours darkness in plants suffering from aucuba mosaic as compared with an increase in the healthy plants. The variations in carbohydrate content in periods of two hours throughout twenty-four hour periods are under investigation as is the nitrogen distribution. In general there appears to be an increase in the total nitrogen content of plants infected with aucuba mosaic as compared with the controls.

Several cases of tomato plants affected by "spotted wilt" have been received at Cheshunt this season. Spotted wilt is an extremely serious disease of tomatoes in Australia, and as it now appears to be of fairly frequent occurrence in this country it is a potential danger to the tomato crop. Studies have been made of this disease on tomatoes and other plants.

Investigations into the mosaic, "stripe," and streak group of diseases have been continued. Ordinary and mild tomato mosaic, of this country, has been identified with true tobacco mosaic, while a single virus distinct from ordinary mosaic has been consistently isolated from "striped" plants.

During the past year methods have been evolved which enables the physiology of the seedling tomato plant to be studied under normal cultural conditions. This involved the elaboration of a number of highly specialised methods.

Work is now in progress with a view to determining the light, temperature, and water relations of photosynthesis, respiration, translocation, and leaf expansion of the seedling tomato plant. A number of interesting indications have already been obtained.

While it is clear that assimilation is dependant upon both light and temperature, at the time of assimilation it has been found that several other factors occur which may modify these relations. There is a considerable amount of evidence to show that assimilation is profoundly influenced by conditions during previous periods of darkness.

The investigation of the temperature relations of the tomato crop has amply confirmed previous experiments which have indicated that the optimum air night temperature is between 63°F. and 65°F. The current experiments showed quite clearly the injurious effect of low night temperatures on the setting of fruit on the two lowest trusses.

The work on the nitrate nitrogen content of a tomato soil and of the drainage from the same soil has been continued. The fluctuations in the nitrate values in the soil were similar to those already recorded. With the soil fallow and unmanured the amount of nitrate nitrogen in the drainage was considerably higher than that found when the soil was manured and cropped. As was the case last year only a portion of the nitrate which disappeared from the soil after watering could be accounted for by nitrates in the drainage. The nitrogen lost in drainage in the form of ammonia was very small and amounted to less than 1% of the nitrogen found in the form of nitrate. The factor which is responsible for the disappearance of nitrate appears to operate in soil which has been partially sterilised by steaming. It has been shown that merely wetting the soil so as to preclude the possibility of leaching may cause a disappearance of nitrate, but the data available suggest that under certain conditions, at all events, the disappearance of nitrate does not mean an actual loss of nitrogen other than that caused by leaching. It appears possible that when the nitrates are decomposed the resulting products are retained in the soil, and these may later give rise to nitrates again.

DIRECTOR'S REPORT.

1. Experimental Results of 1932.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued during the present season. The fruits were collected in numbered baskets and graded in eight grades as follows:—

A.—"Pinks" number 5 to 7 and "Pink and White" 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour; "Pinks" being slightly larger than "Pink and Whites."

B.—"Whites." These fruits are of good colour but smaller than "Pink and Whites."

C.—"Blues." This grade consists of fruit of good colour but larger and more irregular in shape than Grade A.

D.—"Roughs." Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits showing Blossom End Rot.

G.—Fruits showing the lesions of Stripe Disease.

H.—Fruits showing "Green Back."

1. Tomatoes.

(a) Houses 3 and 4. Fertiliser experiment.

The experiment in these houses was designed to determine the relative values of the commoner nitrogenous fertilisers. These were sulphate of ammonia, nitrate of soda, cyanamide, nitrate of lime, dried blood, Peruvian Guano, fish meal, shoddy, and hoof and horn. Cyanamide, hoof and horn and shoddy were applied before planting; of the others, a small portion was given before planting and the remainder fortnightly from the middle of June onwards. The weight of fertiliser was such that each plot received the same quantity of nitrogen.

Following a severe attack of wireworms, in 1931, an application of stable manure, at the rate of 15 tons per acre, was given in the autumn. The soil in both houses was steamed for 1932.

The different fertilisers were not applied for the present crop, as it was anticipated that it would not need them, after sterilization. As this proved to be the case, the experimental results obtained this year can be taken as a measure of the effect of steaming after two years treatment with different nitrogenous fertilisers. It will be seen from Table 1 that the difference in crop which persisted in 1930 and 1931, did not occur in 1932. This is probably due to the application of stable manure and the sterilization which followed. Further, although the crop from the different plots is more uniform than in previous years there are certain differences which suggest a residual effect from the fertilisers even after the soil has been steamed. The experiment will be continued next season.

(b) Planting in trenches.

An experiment was commenced this year, in House 2, to determine if root development in the tomato could be improved either by top-dressing with 6 inches of turf or by planting in trenches and later filling up with a suitable compost. The results are given in Table 2. It will be seen that none of the treatments has increased the yield over that from the control plots in which planting was normal.

When the roots were taken up at the end of the season, root injury by wireworms was observed where fresh turf was used either for top-dressing or for filling up the trenches. Further, there was an exceptional amount of root rot from the trenches. These were 12 inches deep, and in consequence the soil into which the plants were set out was colder and wetter than that near the surface.

Two lessons are to be learned from the experiment, namely, (1) that fresh turf may be dangerous by reason of the wireworms it may contain; (2) that the trenches were too deep for satisfactory early growth.

The experiment will be repeated, but the trenches will be taken out to a depth of 6 inches only.

(c) Variety trials.

The variety trials were continued in House 5 and included new varieties and the progeny of certain crosses made in previous years. An attempt was made to improve the soil in this house by incorporating a layer of turfy soil six inches deep and stable manure at the rate of 15 tons per acre; then steaming the soil to a depth of 2 feet. The compost so formed was rich and promoted a vigorous root action, so that the crop yields given in Table 3 are an indication of the suitability of the different strains for sterilized soil.

Table 1.

Variety—"Ailsa Craig."

House.	Plot.	Compound Tested.	Crop in lbs. per plant.							Total tons per acre.	Average tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.		
3	1	Sulphate of Ammonia	—	1·26	2·12	1·67	0·50	0·14	5·69	43·24	38·27
	5	,, ,, ,, ...	—	0·83	2·19	1·21	0·52	0·25	5·00	38·00	
	10	,, ,, ,, ...	—	0·82	2·26	1·14	0·51	0·02	4·75	36·10	
	14	,, ,, ,, ...	—	0·94	2·15	1·12	0·43	0·06	4·70	35·73	
	2	Nitrate of Soda	—	0·86	1·60	1·37	0·40	0·11	4·34	32·98	34·59
	6	,, ,, ,, ...	—	0·60	2·10	1·26	0·49	0·04	4·49	34·11	
	9	,, ,, ,, ...	—	0·83	2·23	1·30	0·62	0·07	5·05	38·38	
	13	,, ,, ,, ...	—	0·75	1·97	1·16	0·40	0·05	4·33	32·90	
	4	Cyanamide	—	0·86	2·19	1·21	0·52	0·25	5·00	38·00	36·75
	8	,, ...	—	0·78	2·37	1·41	0·52	0·09	5·17	39·29	
	11	,, ...	—	0·68	2·06	1·17	0·40	0·02	4·33	32·91	
	15	,, ...	—	1·00	2·05	1·19	0·53	0·07	4·84	36·78	
	3	Nitrate of Lime	—	0·85	1·82	1·35	0·57	0·09	4·68	35·56	36·00
	7	,, ,, ,, ...	—	0·72	2·21	1·37	0·65	0·06	5·01	38·07	
	12	,, ,, ,, ...	—	0·84	2·06	1·07	0·34	0·04	4·35	33·06	
	16	,, ,, ,, ...	—	1·06	2·17	1·13	0·46	0·09	4·91	37·33	

Table 1 *(continued).*

House.	Plot.	Compound Tested.	Crop in lbs. per plant.							Total tons per acre.	Average tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.		
4	7	Dried Blood...	—	1·12	1·79	1·17	0·48	0·10	4·66	35·41	34·35
	12	,, ,, ...	—	1·26	1·77	0·90	0·42	0·03	4·38	33·28	
	4	Hoof and Horn	—	1·63	1·89	1·12	0·47	0·08	5·19	39·45	38·84
	10	,, ,, ,, ...	—	1·09	2·27	1·07	0·49	0·11	5·03	38·22	
	5	Peruvian Guano	—	1·27	1·83	0·88	0·42	0·09	4·49	34·12	34·88
	9	,, ,, ...	—	1·09	1·93	1·14	0·44	0·09	4·69	35·63	
	8	Fish Manure	—	0·96	2·39	1·14	0·56	0·12	5·17	39·29	37·88
	11	,, ,, ...	—	0·97	2·18	0·99	0·59	0·07	4·80	36·47	
	6	Shoddy	—	1·24	2·20	1·04	0·61	0·20	5·29	40·20	37·43
	13	,, ...	—	1·42	1·52	1·09	0·46	0·07	4·56	34·65	

Variety—E.S. 1.

Table 2.

Plot.	Treatment.	Crop yield in lbs. per plant.							Total tons per acre.	Average tons per acre.
		May.	June.	July.	Aug.	Sept.	Oct.	Total.		
1	Normal planting	0·09	1·86	1·11	1·07	0·69	0·52	5·34	40·59	38·6
6	,, ,, ...	—	1·28	1·44	0·93	0·73	0·29	4·67	35·49	
14	,, ,, ...	0·03	1·74	1·37	0·99	0·71	0·33	5·17	39·72	
2	Top dressed with fresh turf	0·04	1·80	1·19	0·82	0·74	0·43	5·02	38·15	38·02
7	,, ,, ,, ,, ,, ...	—	1·35	1·60	0·89	0·69	0·29	4·82	36·62	
13	,, ,, ,, ,, ,, ...	0·02	1·57	1·48	0·94	0·70	0·46	5·17	39·30	
3	Planted in trenches and later filled up with half peat and half soil from the house ...	—	1·39	1·57	0·84	0·78	0·54	5·12	38·91	36·52
8	,, ,, ,, ,, ,, ,, ,,	—	0·74	1·86	0·82	0·78	0·24	4·45	33·80	
12	,, ,, ,, ,, ,, ,, ,,	—	1·35	1·56	0·92	0·61	0·40	4·85	36·86	
4	Ditto using turf	—	1·43	1·42	0·68	0·67	0·42	4·62	35·11	37·04
11	,, ,, ,, ...	—	1·25	1·65	0·99	0·60	0·36	4·85	36·87	
16	,, ,, ,, ...	0·16	1·80	1·13	0·72	0·82	0·53	5·15	39·14	
5	Ditto using soil from the house ...	—	1·38	1·49	0·90	0·80	0·55	5·12	38·92	37·04
10	,, ,, ,, ,, ,, ,, ...	—	1·00	1·80	0·98	0·62	0·23	4·63	35·20	
15	,, ,, ,, ,, ,, ,, ...	0·03	1·68	1·21	0·84	0·75	0·37	4·88	36·99	

Table 3.

Variety.	Crop yield in lbs. per plant.							Total tons per acre.	Quality of Fruit: percentage in grade.			
	May.	June.	July.	Aug.	Sept.	Oct.	Total.		A.	B.	C.	D.
Pauls No. 12	0·27	2·54	1·53	1·36	0·58	0·44	6·72	51·07	42	11	37	3
E.S.1. Australian Seed	0·18	2·17	1·87	1·54	0·38	0·18	6·32	48·03	69	17	10	2
Maincrop	0·19	1·49	1·74	1·07	0·38	1·25	6·12	46·51	39	4	52	2
Potentate (Fluffy type)	—	2·18	1·87	0·86	0·77	0·31	5·99	45·52	41	6	31	13
Helvetia	0·07	1·61	1·85	1·41	0·76	0·25	5·95	45·22	58	21	18	2
Finchley	0·04	1·79	2·05	1·11	0·71	0·24	5·94	45·07	45	11	41	1
Ailsa Craig	0·09	1·81	1·88	1·44	0·40	0·10	5·72	43·47	58	16	24	2
Franklin Fern	0·05	2·09	1·64	1·11	0·55	0·24	5·68	43·17	48	9	41	1
Table Dainty	0·05	1·57	1·95	1·35	0·55	0·17	5·64	42·86	62	21	13	2
E.S.1	0·01	1·14	1·94	1·54	0·44	0·26	5·33	40·51	58	23	12	5
Tuckwood × E.S.1	0·02	1·22	2·11	1·08	0·54	0·30	5·27	40·05	52	23	22	2
Webb's Conqueror	0·06	1·49	1·73	1·00	0·57	0·29	5·14	39·06	36	11	48	3
Tuckswood × Up-to-date	0·01	0·99	2·29	0·95	0·59	0·28	5·11	38·84	32	16	42	5
Morley's Pride	0·26	1·96	1·58	0·80	0·12	0·26	4·98	37·85	32	7	60	1
Maincrop × Up-to-date No. 2 ...	0·04	1·07	1·84	1·11	0·53	0·11	4·70	35·72	33	19	36	5
E.S.3. × Finchley	0·12	1·64	1·42	1·08	0·36	0·08	4·70	35·72	59	13	25	2
Shevada Gem	0·01	1·16	1·56	1·38	0·36	0·16	4·63	35·19	54	23	17	6
Maincrop × Up-to-date No. 1 ...	0·04	0·83	1·55	1·42	0·44	0·23	4·51	34·28	43	16	35	4
Up-to-date	0·04	1·02	1·33	0·78	0·48	0·16	3·81	28·96	11	4	72	4
Riverside × Up-to-date	—	0·81	1·34	1·00	0·48	0·11	3·74	28·42	25	20	46	9
E.S.1 × Up-to-date	—	0·66	1·51	0·91	0·20	0·29	3·57	27·13	60	19	16	3
Money Maker	0·05	0·62	1·00	1·18	0·13	0·18	3·16	24·02	12	2	73	11
Walker's Recruit	0·16	0·96	0·76	0·79	0·27	0·11	3·05	23·18	28	20	46	5

The most suitable varieties of those tested, judged from the point of setting and balanced growth during the early stages, were E.S.1 from the experimental houses, E.S.1 from Australia (kindly grown by H. T. Rumsey, Esq., of Dundas, New South Wales), Potentate, Helvetia, Ailsa Craig, and both Finchley and Franklin Fern. Shevada Gem grew too luxuriantly during the early stages but gave a good crop later. Morley's Pride, a variety from Jersey, did not prove suitable for steamed soil.

Finchley and Franklin Fern proved to be closely related. They produced long slender leaves with narrow leaflets which gave the foliage a fern-like appearance. The type may prove useful in breeding work, as a means of reducing the foliage of varieties prone to luxurious growth.

The fluffy type of Potentate is a peculiar strain which arose on the nursery of Mr. E. S. Shoults at Hoddesdon, who kindly provided the seed. The stem, leaves and fruits were provided with a dense covering of hairs, which gave the plant a peculiar woolly appearance. This was easily removed from the fruit by rubbing, leaving it of almost normal appearance. The plants proved interesting as the fruit, apart from the hairy covering, was of better shape than the ordinary Potentate and the plants showed no tendency to weakness in the tops. Seed from the fluffy type did not breed true for about 25% were distinctly fluffy, 25% smooth, and 50% were slightly fluffy. An attempt is being made to obtain a pure strain of the smooth type.

Helvetia is a variety which deserves further trial, as the fruit is of a rich red colour.

Various crosses resistant to Leaf Mould were grown. The cropping capacity is being gradually improved and the resistance retained. The best of those tested were E.S.1 × Up-to-date, Tuckswood × Up-to-date, and Riverside × Up-to-date.

(d) Investigation on the reduction in yield of the tomato crop by continuous cultivation in the same soil.

In the Annual Report for 1931, the results of this series of experiments between 1923 and 1931 were reviewed. The rate at which the crop decreased as the result of cultivating tomatoes in the same soil, year after year, was discussed and it was suggested that, apart from the influence of the plant itself, the reduction in yield appeared to be connected with the continual use of horse manure and the destruction of coarse organic material which is so necessary to keep the soil in suitable physical condition and also supply food for the growth of soil organisms.

In these experiments and in trials on commercial nurseries, the use of such materials as plain straw, peat and chrysanthemum roots has proved beneficial where the soil, heavily manured for long periods, has become unsuitable for tomato production.

It was also found in 1931, that the incorporation of chrysanthemum roots and also peat after the soil had been steamed caused an increase in crop.

These experiments have been repeated in 1932, the results being given in Table 4.

In House 7, another application of chrysanthemum roots was given to half of Plot 1 previously enriched by this material after steaming for 1931. A dressing of peat was also given for the first time to Plot 6. The average weight from the control plots was 50·7 tons per acre. The plot treated with peat in 1931 gave 54·5 tons per acre and that treated similarly for 1932 gave 53·4 tons per acre. Plot 1b treated with chrysanthemum roots for 1931 gave 57·1 tons per acre, while Plot 1a to which chrysanthemum roots were applied again this year gave 68·8 tons per acre.

The results from House 8 are included in the Table for record purposes but they cannot be regarded seriously, as the plants were attacked by *Verticillium Wilt* which materially affected the yield.

It is, however, interesting to note that the cleanest plot was that to which peat had been added. This fact is reflected in the yield.

House 9 was sterilized with steam for 1932. Prior to this the second spit of Plot 2 was treated liberally with emulsified dichlorphenol and that of Plot 7 with formaldehyde (both diluted at the rate of 1 gallon in 49 gallons of water). The object of this was to retard the movement of organisms from the soil beneath into the sterilized portion. The effect of such treatment should show in 1933.

Following the beneficial effect of adding peat after steaming which was obtained in House 7 Plot 2, 1931, three different samples of peat were tested. Sample A., Plot 3, was a good type of sphagnum peat from Scotland, sample B. a sedge peat from the West of England, and sample C. a sphagnum peat imported from abroad.

It will be seen that none of these treatments affected the yield materially and that there was little difference between them. The addition of straw to the second spit was also without effect but some increase was obtained after incorporating chrysanthemum roots with the steamed soil.

Table 4.

House.	Plot.	Treatment.	Crop yield in lbs. per plant.							Total tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.	
7	1a	Chrysanthemum roots added for 1931 and 1932 ...	0·02	2·03	2·68	2·29	1·18	0·97	9·17	68·83
	1b	Chrysanthemum roots added for 1931	0·03	1·60	2·05	1·95	1·34	0·45	7·42	57·14
	2	Peat C added 1931	0·05	1·90	1·76	1·64	1·32	0·50	7·17	54·49
	3	Control	0·06	1·83	1·73	1·97	1·22	0·42	7·23	53·90
	4	Control	0·02	1·17	1·83	1·59	1·05	0·93	6·59	50·08
	5	Control	0·04	1·64	1·72	1·54	0·99	0·42	6·35	48·25
	6	Peat C added 1932	0·02	1·30	2·07	1·55	1·10	0·99	7·03	53·42
	7	Control	0·04	1·63	1·88	1·37	0·88	0·44	6·24	48·02
	8a	Control	0·03	1·66	2·00	1·71	1·17	0·45	7·02	53·24
	8b	Soil heated electrically : plate method	0·03	1·33	2·06	2·03	1·32	0·65	7·42	56·39
8	1	Soil heated electrically : plate method	—	0·99	1·69	1·06	1·11	0·34	5·19	39·44
	2	Peat C : half dressing 1932	—	1·23	2·25	1·09	0·85	0·40	5·82	44·21
	3	Straw in second spit	—	1·30	1·80	0·77	0·71	0·62	5·20	39·51
	4	Chrysanthemum roots added 1932	—	1·32	1·84	0·88	0·53	0·31	4·88	37·07
	5	Control	—	0·76	2·19	1·38	0·85	0·48	5·66	43·01
	6	Old tomato roots added 1931	—	1·02	1·74	1·57	0·54	0·31	5·18	39·43
	7	Chrysanthemum roots added 1932	—	1·53	1·81	0·97	0·27	0·12	4·70	35·72
	8	Control	—	1·18	1·69	0·79	0·39	0·22	4·27	32·44

Table 4 *(continued).*

House.	Plot.	Treatment.	Crop yield in lbs. per plant.							Total tons per acre.
			May.	June.	July.	Aug.	Sept.	Oct.	Total.	
9	1	Steamed : Control	—	1·09	2·32	1·54	1·08	0·61	6·64	50·46
	2	Steamed : 2nd spit treated with dichlorphenol ...	—	1·12	2·53	1·62	0·95	0·61	6·83	51·89
	3	Steamed : Peat A added	—	1·09	2·63	1·69	0·83	0·30	6·55	49·77
	4	Steamed : Peat B added	—	0·83	1·97	1·52	0·89	0·49	6·30	47·12
	5	Steamed : Peat C added	—	0·36	2·80	1·84	0·83	0·28	6·08	46·18
	6a	Steamed : Straw added	—	0·65	2·76	1·56	1·14	0·43	6·54	49·68
	6b	Steamed : Chrysanthemum roots added	—	0·79	3·07	1·67	1·23	0·31	7·07	53·74
	7	Steamed : 2nd spit treated with formaldehyde ...	—	0·72	2·76	1·71	0·74	0·35	6·28	47·73
	8	Steamed : Peat B added	—	0·72	2·81	1·61	0·83	0·79	6·86	52·13
10	1	Control	—	0·44	2·29	0·98	0·61	0·51	4·83	36·71
	2a	Ammonia liquors	—	0·47	1·97	0·97	0·70	0·51	4·62	35·11
	2b	Seaweed ash	—	0·48	2·15	0·72	1·12	0·41	4·88	37·09
	3	Control	—	0·47	1·99	0·81	0·75	0·44	4·46	33·89
	4a	Planted 1929-1932	—	0·42	2·06	0·91	0·94	0·29	4·62	35·12
	4b	Planted 1931 and 1932...	—	0·41	2·33	1·06	1·02	0·17	4·99	37·92
	4c	Clean tomato roots added in 1931	—	0·44	2·74	1·31	0·92	0·31	5·72	43·47
	5a	Potatoes grown 1931	—	0·31	3·11	2·11	1·25	0·27	7·05	53·58
	5b	Turnips grown 1931	—	0·29	2·86	1·89	1·03	0·42	6·49	49·32
	5c	Planted 1932	—	0·38	2·80	1·85	1·19	0·45	6·67	50·70
	6	Chrysanthemum roots added	—	0·42	2·17	1·04	0·63	0·37	4·63	35·19
	7	Hops added	—	0·46	2·42	1·32	0·98	0·32	5·50	41·80
	8	Peat A added	—	0·34	2·41	1·11	0·75	0·27	4·88	37·09

It will be remembered that House 10 was practically without fertiliser treatment from 1923 to 1929. In 1930 it was limed and in 1931 limed again and for the first time received the normal manurial treatment.

The yield from this house is usually low and this year the average crop from the control plots was 35·3 tons per acre. Treatment of different plots with ammonia liquors, sea weed ash and chrysanthemum roots did not affect the yield materially but a dressing of peat at the rate of 30 tons per acre greatly improved Plot 8 to which it was applied.

This plot has always been the worst plot in the four houses, and a crop of 37 tons per acre obtained this year after adding peat shows a considerable improvement.

The most successful treatment in this house was the application of spent hops at the rate of 15 tons per acre. Care was taken to mix the hops as well as possible with the soil, taking precautions to prevent much of the material lying exposed on the surface as this encourages the growth of *Botrytis*. A yield of 41·8 tons per acre marks a valuable crop increase.

The south quarter of House 10 was allocated in 1929 to a small experiment designed to throw some light on the problem of reduced yield. The soil was renewed to a depth of 2 feet with good virgin turf with the exception of one plot, 4a. The area was manured in the usual way and was allowed to remain fallow. After two years of this treatment, Plot 4b was planted with tomatoes; to Plot 4c a large quantity of healthy tomato roots was added from plants grown specially for the purpose. Plot 5a supported two crops of potatoes and Plot 5b a crop of turnips, while Plot 5c remained fallow.

In 1932 all the plots were planted with tomatoes. The results are given in Table 4.

Plot 4a, cropped 1929 to 1932, gave the lowest yield of 35 tons per acre; Plot 4b, cropped 1931 and 1932 gave 38 tons per acre; the control, Plot 5c, planted in 1932 for the first time yielded 50 tons per acre. The reduction in yield following continuous cultivation will be seen from this. The addition of tomato roots, Plot 4c, in 1931 reduced the 1932 crop from 50·7 tons per acre to 43·5 tons per acre. The previous crop of turnips or potatoes did not adversely affect the soil for the following tomato crop.

Results from such an experiment cannot be taken as being in any way conclusive but they suggest that the reduction in yield may be associated with some product left in the soil by the tomato roots. The investigation will be continued.

Table 5.

House.	Plot.	Treatment. 1928.	1929.	1930.	1931.	1932.	Grade of Fruit: Percentage. A.	B.	C.	D.	E.	F.	G.	H.	Total lbs. per plant	Total tons per acre.	Average tons per acre.
11	1	No Lime	No Lime	Lime	Lime	Lime	65·17	23·54	1·01	5·02	3·85	0·18	1·23	—	5·98	45·45	
	2	,,	,,	,,	,,	,,	67·28	25·92	0·69	3·48	2·10	—	0·53	—	5·70	43·40	
	5	,,	,,	,,	,,	,,	68·21	25·77	0·66	2·34	1·68	0·82	0·52	—	5·95	45·24	44·43
	6	,,	,,	,,	,,	,,	68·98	25·09	0·53	3·64	1·40	0·18	0·18	—	5·74	43·64	
	3	,,	,,	No Lime	No Lime	No Lime	68·53	24·79	0·67	4·27	1·39	—	0·34	—	5·85	44·49	
	4	,,	,,	,,	,,	,,	71·94	22·05	0·34	3·96	1·19	—	0·52	—	5·85	44·49	
	7	,,	,,	,,	,,	,,	63·44	30·20	0·66	4·20	1·50	—	—	—	5·96	45·27	44·75
	8	,,	,,	,,	,,	,,	68·42	25·48	0·67	2·89	2·21	—	0·34	—	5·89	44·74	

Table 6.

Variety—" Butcher's Disease Resister."

House.	Plot.	Treatment during 1932.	Pounds per plant.								Total		
			Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Total.	Tons per Acre.		Flats per foot.
C.	1	Base Steamed. Bed at normal temperature	2·27	12·29	10·93	13·56	8·79	10·35	1·78	59·97	89·96	91·44	1·85
	3	,, ,, ,, ,, ,, ,, ...	1·29	11·16	11·89	14·29	9·40	11·43	2·49	61·95	92·93		1·91
	2	,, ,, Bed heated by electric method using galvanised iron wires. Temperature 87° F. Heating ended, June 30th	0·67	9·50	12·82	14·86	8·96	10·15	3·27	60·23	90·35	95·66	1·86
	4	,, ,, ,, ,, ,, ,, ,,	2·95	12·87	11·98	14·15	9·34	13·05	2·98	67·32	100·98		2·08
D.	1	,, ,, New variety. Butcher's Disease X a Danish type	1·67	9·07	8·92	9·13	7·46	8·00	2·15	46·40	69·60	76·94	1·43
	8	,, ,, ,, ,, ,, ,, ,, ,,	2·87	11·77	10·72	12·11	10·01	7·08	1·63	56·19	84·29		1·73
	2	,, ,, Bed at normal temperature	5·02	15·10	10·06	12·39	10·48	9·96	2·23	65·24	97·86	96·37	2·01
	4	,, ,, ,, ,, ,, ,, ...	2·97	14·25	9·29	13·57	10·53	9·96	2·68	63·25	94·88		1·95
	5	,, ,, Bed heated using two strands of insulated wire. Temperature 80° F. Heating ended June 30th	3·64	13·52	10·51	12·71	11·41	13·07	2·36	67·22	100·83		2·07
	6	,, ,, Bed heated using eight strands of insulated wire. Temperature 80° F. Heating ended June 30th	4·90	14·85	10·19	14·29	11·61	14·37	2·50	72·71	109·07		2·24
	7	,, ,, Bed heated using eight strands of insulated wire. Temperature 95° F. Heating ended June 30th	4·97	13·38	10·89	13·23	11·16	10·26	2·77	66·66	99·99		2·06
	3	,, ,, Bed heated electrically by means of six strands of insulated wire. Temperature 78° F. Heating ended June 30th	4·55	14·39	10·67	13·01	10·84	2·76	1·64	57·86	86·79		1·79

Table 6 *(continued).*

House.	Plot.	Treatment during 1932.	Pounds per plant.							Total.	
			Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Total.	Tons per Acre.	Flats per foot.
E.	3	Base Steamed Bed at normal temperature	4·19	13·65	9·96	12·51	11·54	8·21	1·52	61·58	92·37 } 86·69	1·90
	7	,, ,, ,, ,, ,, ,, ...	4·96	12·27	7·93	10·00	9·68	7·76	1·41	54·01	81·02 }	1·66
	4	,, ,, Bed heated using four strands of insulated wire. Temperature 79° F. Heating ended June 30th	3·96	13·46	10·60	14·63	14·01	12·13	2·61	71·40	107·10	2·20
	5	Unsterilised. Bed at normal temperature	2·98	12·17	7·56	10·36	9·01	5·36	1·04	48·48	72·72	1·50
	6	,, Bed heated by Swedish cable. Temperature 88° F. Heating ended September 30th ...	4·87	13·09	9·43	12·37	11·48	11·07	1·71	64·02	96·03	2·00
F.	1	Base Steamed. Bed at normal temperature	4·92	13·45	8·75	11·83	8·58	10·46	2·42	60·41	90·62 } 95·46	1·86
	3	,, ,, ,, ,, ,, ,, ...	3·56	15·88	10·33	12·75	11·68	11·37	1·30	66·87	100·31 }	2·06
	2	,, ,, Bed heated by passing electric current between two galvanized iron plates. Temperature 85° F. Heating ended September 30th ...	4·71	14·07	10·37	15·04	11·20	10·37	2·16	67·92	101·88	2·10
	4	,, ,, Bed heated using galvanized iron wires. Temperature 98° F. Heating ended July 31st	3·42	13·88	9·90	11·75	10·44	10·36	1·70	61·45	92·18	1·90
	5	,, ,, As 4. Temperature 95° F. Heating ended July 31st	3·18	14·57	9·73	11·94	11·20	11·48	1·73	63·83	95·75	1·97
	6	,, ,, As 4. Temperature 88° F. Heating ended September 30th	3·93	14·94	9·28	12·97	11·22	12·37	2·49	67·20	100·80	2·08
	7	,, ,, As 4. Temperature 87° F. Heating ended September 30th	4·56	13·71	9·47	13·16	11·46	14·69	3·46	70·51	105·77	2·17

(e) Lime.

The liming experiment in Houses 11 and 12 was continued but as it was necessary to use House 12 for a variety trial, data can only be taken from House 11 for the current season.

The results are shown in Table 5.

Four plots, 1, 2, 5 and 6, were not limed for the first two years but were given the usual treatment during 1930 to 1932. Plots 3, 4, 7 and 8 have never received any lime since the houses were built and the soil is definitely sour. The average yield from the limed plots is 44·43 tons per acre and from the unlimed plots 44·75 tons per acre. The yields from the various plots are particularly uniform.

The results confirm previous indications that the tomato crop can tolerate some soil acidity and that the application of lime, except for physical reasons, is not as important as it was considered to be.

2. Cucumber Experiments.

In 1931, the soil heating experiments previously confined to tomatoes were extended to cucumbers, using the control plot in House E for the purpose. This plot was divided into two equal plots, of which E5 was the control, E6 being heated by electric cables laid beneath the beds; it was found that the cucumber crop can be increased appreciably by raising the bed 15°F. above the usual temperature. The problem was investigated on a larger scale during the present season.

An attempt was made to have a range of soil temperatures and also to heat certain plots or part of the season and others during the whole season.

The beds were heated from 10 p.m. to 6 a.m. and the results are given in Table 6. On the unsterilized bed, E6, a crop increase of 33% was obtained by raising the soil temperature some 15°F. above the normal. This confirms the result obtained in 1931.

In all the plots with sterilized soil on which the crop was normally high the rate af increase was of the order of only 8 or 10%.

This is a most interesting result, as it suggests that the injurious influences which accumulate in cucumber beds, and which are destroyed by steam sterilization, are prevented from injuring the cucumber plant at the higher soil temperatures.

The experiments also indicate that a mean bed temperature of 88°F. is about the optimum for the cucumber, and that higher temperatures are undesirable. They also show that the crop increase continues as the heating is continued, but that the cost of heating the soil during August and September is probably not recovered in the value of the additional crop.

A new method of electric heating was tested in Plot F2, with the co-operation of Mr. Lloyd Owen, of the County of London Electric Supply Co. This consisted of placing galvanised sheet electrodes at the front and back of the beds and heating the soil by passing an electric current through the soil between these electrodes. The alternating current of 40 volts caused no injurious effects on the plants and the warmer bed produced a crop increase of some 7%.

The problem of soil heating will be further investigated in 1933.

3. Lettuce.

The possibility of growing lettuce as a winter crop before tomatoes was examined further. All the tomato houses were prepared for tomatoes by the first week in December, 1931, and were then planted with young lettuce plants from boxes, following the method described in the Seventeenth Annual Report. The variety selected was Golden Ball and the crop was marketed by the end of March, 1932.

The crop was successful and showed a good profit, £111 being taken from a third of an acre.

By breeding and selection it is hoped to raise a new type of lettuce which will heart well during the short winter days. Some results have been obtained already and the future is hopeful.

Growers are urged to take up the cultivation of lettuce as a winter catch crop. Information on this subject will be given gladly to those who require it.

2. Mycological Investigations

Diseases brought to the Station and not previously reported are listed below:—

Host.	Disease.	Cause.
Amaryllis	Root rot	*Fusarium sp.*
Antirrhinum	Leaf spot	*Phyllosticta antirrhini*
Chrysanthemum ...	Spotted wilt	*Virus.*
Cinerarea	Spotted wilt	*Virus.*
Crinum	Root rot	*Fusarium sp.*
Dahlia	Spotted wilt	*Virus.*
French Bean	Mosaic	*Virus.*
Pelargonium	Mosaic	*Virus.*
Tomato	Spotted wilt	*Virus.*

1. Leafy Gall of the Chrysanthemum.

P. H. Williams.

Leafy gall of the chrysanthemum has been known for some years, specimens having been sent in from time to time. It has been regarded as a form of "Crown Gall," a disease which attacks a large number of hosts, and has not appeared to be serious until quite recently. Now, however, it has become more common, especially on certain varieties, such as Phyllis Cooper. It seemed desirable, therefore, to investigate its cause and if possible to find a control.

Symptoms.

In the normal chrysanthemum shoots are sent up from the base of the plant, the number and the time at which they appear depending on the variety. These shoots are used for cuttings. In plants suffering from leafy gall the shoots branch repeatedly, forming a dense mass of short shoots with small distorted leaves. Sometimes the infected shoot does not branch but becomes thickened with fleshy leaves. The number of shoots suitable for cuttings is consequently much reduced. The plants are also weakened by these growths, which drew most of their food supplies from the parent plant. This is demonstrated by the fact that the galls soon die and decay when the plants are cut down at the end of the season.

Incidence and varietal susceptibility.

The chrysanthemum crop at the Station was examined at fortnightly intervals during 1932 in order to determine the time at which leafy gall made its appearance and the degree of varietal susceptibility. Single plants of the varieties Favourite, Jean Patterson, Balcombe Beauty, Phyllis Cooper,

Cheshunt White and Baldock's Crimson were found to be infected on July 26th. The greatest number of galls, however, did not appear until the middle of December. Table 1 shows the number of pots which contained infected plants on December 19th. Except in the case of Phyllis Cooper, which was very severely infected, not more than one plant was usually infected per pot, but since it is undesirable to take cuttings from pots showing infection, the Table gives an indication of the losses due to this disease.

Table 1.

Varietal susceptibility to Leafy Gall.

Variety.	No. of Pots.	No. Infected.	Per cent. Infected.
Phyllis Cooper (clean stock)	9	7	77·7
Phyllis Cooper (infected stock)	38	24	63·1
Mary Morris	49	14	28·5
Jean Patterson	43	12	27·9
Friendly Rival	43	8	18·6
Crimson Conquest	18	3	16·6
Thanksgiving Pink	32	5	15·6
Balcombe Beauty	336	45	13·4
Favourite	190	15	7·9
Baldock's Crimson	26	2	7·7
Cheshunt White	194	4	2·1

The disease also occurred on plants of the varieties: Late Pink, J. W. Streeter, White Monument, Golden Marvel and Framfield Crimson. In these cases the number of plants of each variety grown was too small for inclusion in the Table. No gall was observed on Mrs. G. Monro, J. Symonds, Thalia and Chiltern White.

The Organism.

Several unsuccessful attempts have been made in previous years to isolate the organism, *Bacterium tumefaciens*, which was thought to be the cause of Leafy Gall. At the end of 1931, however, isolations were made, using Bile Salt Agar according to a method described by M. K. Patel. Several cultures were obtained which resembled very closely a pure culture of *B. tumefaciens* obtained from the Lister Institute. Six of these cultures were plated several times to ensure purity, and have been used in the cultural and inoculation studies described below. At the same time isolations were made from a normal crown gall growing beneath the soil level on a young chrysanthemum shoot. A culture from this source was included in the studies.

Growth in pure culture.

All these organisms are small rods, 1·0-2·4 × 0·5μ. They are motile but it has not been possible to demonstrate flagellæ.

A. Organism from Leafy Gall.

Plate Cultures on Beef Extract Agar.

Circular, cream with yellower centre, 2 mm. in diameter, raised, smooth, shining, translucent.

Streak Cultures on Beef Extract Agar.

White, slight brown tinge, smooth, shining, raised.

Plate Cultures on Beef Extract Gelatine.

White with brownish tinge, smooth, shining, raised. Submerged colonies round, yellowish. No liquefaction.

Stab Cultures on Beef Extract Gelatine.

White, growth on surface and along stab. No liquefaction.

Beef Extract Bouillon.

The medium became turbid, white pellicle with gelatinous threads hanging down from it and white flocculent precipitate.

Durham's Solution.

Growth similar to that in Bouillon. No indol formed.

Peptone Water and Potassium Nitrate.

Growth similar to that in Bouillon. The nitrate was not reduced.

Peptone Water and Glucose.

Acid was formed but no gas and the litmus was partially bleached. The medium remained clear and there was a heavy pellicle and slight precipitate.

Peptone Water and Lactose.

Reactions similar to those in Glucose, except that the litmus was not bleached.

Peptone Water and Glycerine.

Reactions similar to those in Glucose.

Peptone Water and Sucrose.

Reactions similar to those in Glucose.

Milk.

The medium became brownish white. There was evidence of slight peptonisation but no curd was formed. A white pellicle, later becoming yellow, and a white precipitate were present.

Litmus Milk.

Litmus milk became blue, then grey, and finally brown. There was slight peptonisation at the top but no curd.

Steamed Potato Cylinder.

The growth was brown, smooth, shining, raised. The medium was discoloured.

Uschinsky's Solution.

The medium became alkaline and turbid with pellicle and precipitate.

B. Organism from Crown Gall.

The reactions of this organism were similar to those described above, except that it did not grow in Peptone water containing sugars, and that Milk remained white instead of becoming brown.

C. Bacterium tumefaciens.

B. tumefaciens slightly reduced the nitrate when grown in Peptone water containing Potassium nitrate. The growth on steamed Potato was dark brown and rather scanty. In all other respects its reactions resembled closely those of the organism isolated from Leafy Gall.

From these experiments it is suggested provisionally that the organisms isolated from Leafy Gall and Crown Gall of the Chrysanthemum are strains of *B. tumefaciens*.

Pathogenicity.

Chrysanthemum.

Cuttings of the variety Balcombe Beauty were obtained from healthy plants and rooted in sterile sand. Later they were potted in sterile compost and pots. Certain of these plants developed Leafy Gall during the course of the season.

Soil Inoculations.

Young plants were inoculated at the beginning of March by pouring 25 cc. of a broth culture on to the surface of the soil. This was repeated four times to ensure infection. Eighteen plants were inoculated with various strains of the organism from Leafy Gall, three with that from Crown Gall and six with *B tumefaciens*. Three plants received sterile broth and served as controls. No results were observed for some months and part of the plants were discarded at the end of August in order to make room for other experiments. The remainder were left until the end of the year when it was found that some had developed typical Leafy Gall. The results are given in Table 2, which assumes that the plants discarded would have remained healthy.

Table 2.

Production of Leafy Gall by soil inoculation.

Inoculum.	Infested.	Healthy.
Bacterium from Leafy Gall ...	5	13
Bacterium from Crown Gall ...	2	1
B. tumefaciens	0	6
Control	0	3

Although the control plants remained healthy, the fact that some of the other plants in the general stock, from which these plants were taken, developed the gall naturally makes the results of this experiment suggestive rather than conclusive. The experiment will be repeated on a larger and more satisfactory scale during the coming season.

Stem Inoculations.

Young plants were inoculated by pricking the organisms into the stem near the tip. Twelve plants were inoculated with the organism from Leafy Gall, two with that from Crown Gall and two with *B. tumefaciens*. There were two controls. It was found that most of the plants inoculated with the Leafy Gall organism produced slight swellings at the point of inoculation. In two cases this swelling was large enough to be considered a definite infection, but in the others it seemed to be in the nature of a wound reaction. The organism from Crown Gall and *B. tumefaciens* produced definite galls.

In a further experiment an attempt was made to inoculate the organism as near the growing point as possible. The injury done to the young tissues caused considerable distortion and no definite result could be obtained.

These results suggest that the organism isolated is pathogenic to the Chrysanthemum, but further experiments are necessary to ascertain the best method of inoculation.

Tomato.

Young Tomato plants about 6 inches high were inoculated by pricking the organism into the stem near the growing point. In certain of the plants inoculated with bacteria from Leafy Gall, swellings $\frac{1}{8}$ inch in height and $\frac{1}{4}$ inch in length were produced. In other cases slight swellings appeared which might have been due to wound reaction and were classified as "doubtful." In no case was the swelling large enough to permit re-isolation. The other bacteria produced comparatively large irregular galls. The results were summarised in Table 3.

Table 3.

Results of Tomato Inoculations.

Experiment 1:—	Infected.	Doubtful.	Healthy.
Bacterium from Leafy Gall ...	3	4	11
Bacterium from Crown Gall ...	3	0	0
B. tumefaciens	3	0	0
Control	0	0	3
Experiment 2:—			
Bacterium from Leafy Gall ...	8	1	9
Bacterium from Crown Gall ...	3	0	0
B. tumefaciens	3	0	0
Control	0	0	3

Tobacco.

No infection was obtained when the bacterium from Leafy Gall was inoculated into young Tobacco stems. *B. tumefaciens* regularly produced large woody galls, while the Crown Gall organism gave large leafy galls.

Pelargonium.

Very slight infection occurred on one Pelargonium plant out of fifteen inoculated with the Leafy Gall organism, while the other strains produced large irregular galls in all cases.

Tropaeolum.

One plant was infected out of ten inoculated with the Leafy Gall organism. *B. tumefaciens* also produced one small gall.

French Bean.

The Leafy Gall organism did not infect French Beans when pricked into the stem. The Crown Gall bacterium and *B. tumefaciens* caused galls in several cases.

These experiments suggest that the bacterium isolated from Leafy Gall is pathogenic and closely related to *B. tumefaciens*. The galls produced by it were very slow in developing and altogether it showed much less virulence than the pure culture of *B. tumefaciens* and the strain isolated from Crown Gall of the Chrysanthemum. It is, however, well known that strains of *B. tumefaciens* even from the same source may differ markedly in their virulence.

Control.

In many cases apparently healthy shoots grow away from the gall and may be used for cuttings. A number of such shoots were propagated under sterile conditions and developed the gall in a large proportion of cases. This suggests that these shoots may be contaminated and should not be used for propagating.

Assuming that the disease is due to a bacterial parasite it seems probable that the soil is also a common source of infection. Some form of sterilisation would undoubtedly be effective in preventing the disease. It may also be possible to make conditions unsuitable for the growth of the organism by incorporating some substance in the potting soil or watering it on to the growing plant. A preliminary experiment on these lines has been carried out this year. Plants of the varieties: Cheshunt White, Favourite, Baldock's Crimson, Phyllis Cooper and Balcombe Beauty were treated by fortnightly applications of the following solutions:--

Mercuric chloride 1/1000.

Emulsified cresylic acid 1/1000.

Potassium permanganate 1/100.

Formaldehyde 1/100 (1 part 40% formaldehyde in 99 parts water).

Sulphuric acid 1/100.

Ferrous sulphate 1/200.

The experiment was not begun until July 6th and was chiefly of value in determining the strength at which these substances could be used with safety.

Only the plants treated with sulphuric acid remained entirely free from the disease. The mercuric chloride, formaldehyde and sulphuric acid treatments proved toxic to the plants.

The incorporation of sulphur with the soil has been used with success for the control of Crown Gall in the Apple. Chrysanthemum cuttings were therefore potted up in soil to which flowers of sulphur had been added. The results showed that 0·5% of sulphur in the soil was toxic to both Cheshunt White and Balcombe Beauty, while 0·25% was toxic to Cheshunt White only, the Balcombe Beauty plants developing normally. No galls were seen

Summary.

(1) A disease of the Chrysanthemum is described which takes the form of a Leafy Gall at the base of the stem.

(2) A bacterium has been isolated from these galls which resembles *B. tumefaciens* very closely and has produced small galls when inoculated into the stems of various plants.

(3) Preliminary experiments on the control of the disease have been carried out.

2. Virus Disease Investigations.

G. C. Ainsworth.

(a) Spotted Wilt of Tomatoes.

During the past season tomato plants suffering from spotted wilt were received at Cheshunt, for the first time, from several widely separated places in Great Britain, and it would appear that the disease is now of frequent occurrence in this country and liable to cause considerable losses to growers of tomatoes and other plants.

Spotted wilt was first described in Australia, where it is a most serious disease of tomatoes, and appeared to be confined to that country, but recently it has been shown to be widely distributed and was first recorded in England last year.

The virus has been studied and the symptoms produced on different host plants correspond very closely with the descriptions given by other workers. There is no doubt that the disease is identical with spotted wilt of Australia, but it is distinct from the "stripe disease" of this country with which in the past it has probably been confused (for a comparison with "stripe" see p. 46).

Symptoms.

Short descriptions of the symptoms produced on different plants by experimental inoculation will be given.

Tomato (*Lycopersicum esculentum*). The first symptom is a sudden bronzing of the young leaves accompanied by almost complete cessation of growth. The intensity of the bronzing varies from very slight to severe and takes the form of irregular spots, circles or rings which may completely cover large areas when the surface of the leaf appears glazed. Another early symptom especially noticeable in young plants is the downward and inward curling of the young leaves. The affected plants become very stunted but are rarely killed, unless infected when seedlings, and, under good growing conditions, 10—15 days after the initial bronzing slow growth may recommence; frequently due to the development of a

lateral shoot. The new growth at first appears healthy but usually bronze markings develop and the shoot dies back. Other laterals may develop and this gives the plant a bushy appearance. Another late symptom is a yellow mottle recalling aucuba mosaic. A plant may live in this condition for some months but no plant has been observed to outgrow or recover from this disease. Fruit may be produced which is often marked. The markings take the form of yellow concentric rings which develop when the fruit ripens or as bronze coloured rings on the green fruit. A quantity of marked fruit was received from growers and a few ringed fruits developed on the experimental plants. The majority of the fruits developed on the experimental plants, however, although small were unmarked. It was found impossible to detect the virus in ripe fruits though its presence in green fruit was demonstrated.

Tobacco (*Nicotiana tabacum*). Large necrotic local lesions are produced which show more or less distinct zonation. In some instances these are the only symptoms, but systemic infection often takes place when necrotic lesions suddenly develop in the younger leaves, which soon collapse and the plants are frequently killed.

N. macrophylla is similar to *N. tabacum*.

N. glutinosa appears to be very susceptible. Zoned necrotic local lesions appear and a severe systemic necrosis follows which eventually kills the plant.

Datura Stramonium is easily infected. Numbers of necrotic rings develop on the inoculated leaves and systemic infection results in a mottle, necrosis and leaf distortion.

N. glutinosa and *D. Stramonium* are useful plants for the purification of spotted wilt when mixed with tomato mosaic or "stripe," for although all three diseases give local lesions on these plants only spotted wilt becomes systemic.

"Winter Cherry" (*Solanum capsicastrum*). The symptoms are markings on the leaves which take the form of concentric rings, and stunting.

Petunia (garden variety). The only symptoms are concentrically zoned local necrotic lesions which develop in 2—6 days. No systemic infection has been observed.

Dahlia. Pale yellow circles or rings on the leaves. In one instance this season an attack of spotted wilt on tomatoes was traced to dahlias in which the virus had overwintered.

Garden Nasturtium (*Tropaeolum majus*) was infected. Yellow spots develop on the leaves together with some distortion and marked stunting.

CINERAREA. Mr. W. Corbett, of Swanley, brought to Cheshunt cinerarea plants suffering from a severe vein necrosis. The plants eventually died. Spotted wilt was isolated from these plants and produced similar symptoms on cinerarea plants by artificial inoculation.

CHRYSANTHEMUM. During December chrysanthemums showing brown areas on the leaves, small lesions on the stems, and a withering of the flowers, were received from a grower who had had a serious attack of spotted wilt on tomatoes in the spring. Spotted wilt was isolated from the chrysanthemums. Every variety was stated to be affected.

The host range of spotted wilt is wide and the following plants of interest to growers have been reported to be susceptible to the disease: Potato, schizanthus, zinia, aster, Iceland poppy, lupin, broad bean, *Campanula pyramidalis*, and common plantain.

Transmission.

The most important agent in the natural spread of spotted wilt is the Onion thrips, *Thrips tabaci* Lind.

In the experimental work reported above artificial inoculation only was used. Leaves of the plant to be inoculated were lightly rubbed with cheese cloth dipped in infected juice. The percentage of infection was satisfactory, as shown for example below:—

	No. of Plants Inoculated.	No. Infected.
Tomato ...	32 ...	18
Tobacco ...	33 ...	27 (13 local lesions only)

In single experiments with both tomato and tobacco the infection was frequently 100%.

The disease is thus transmissible by juice inoculations and could be spread by the hands and pruning knife, but it is less infectious than tomato mosaic.

Feeding marks of leaf hoppers were seen on several diseased plants examined and a few nymphs found. It was thought that perhaps leaf hoppers were a vector. A stock of *Erythroneura parvula*, Boh. (which frequently occurs in glasshouses) was bred on tomato plants from nymphs received from Guernsey. Nymphs and adults were colonised on tomato plants infected with spotted wilt and then transferred to healthy plants, but no evidence of transmission was obtained. A few experiments were also performed with tomato mosaic and aucuba mosaic, but again results were negative.

Infected juice was found to become rapidly inactive in vitro. It was found impossible to filter the juice through Pasteur-Chamberland filters even when the whole operation, including inoculation of the plants, was completed in 45 minutes, a period which leaves unfiltered juice still active.

Experiments were performed to see whether by suitable treatment plants could be induced to outgrow the disease, but they were uniformly unsuccessful. Neither the application of manures nor high temperature and humidity appeared to influence the course of the disease.

Control.

Suggested measures for control are:—

1. To keep the plants as free as possible from insects, especially Thrips.
2. To rogue out at once plants developing the disease, and
3. To eradicate alternate hosts, especially those in which the virus could overwinter.

Summary.

Spotted wilt, a virus disease of tomatoes, is described. A list of plants reported to be susceptible to this disease is given and notes on its transmission, properties of the virus, and suggestions for control.

(b) Mosaic and "Stripe" Disease of Tomatoes.

The study of "Stripe" disease has been continued.

The symptoms on tomato of the disease generally known in this country as "Stripe" are well known.

"'Stripe' is characterised by brown longitudinal markings or stripes on the stem, by shrivelling of the leaves and by sunken irregularly shaped pits usually of a brown colour on the fruit" (5th Annual Report, page 22).

It has also been realised that there is some connection between "Stripe" and a form of "Mosaic," for plants which outgrow an attack of "Stripe" are often mottled. "Stripe" symptoms may, however, be due to several causes—a bacterium (see 5th Annual Report), a single virus, or a mixture of viruses, and it is of some importance to know the type of "Stripe" in any outbreak as the methods of control differ. Plants affected by "Stripe" due to a bacterium (*B. lathyri*) or the single virus described below, tend to outgrow the attack when treated with potash, and the disease is intensified when there is a deficiency of potash in the soil (see 17th Annual Report, page 43), while potash is useless when plants are affected by a mixed virus "Stripe." In such cases application of nitrogen is indicated.

In the past spotted wilt has been confused with "Stripe," but it has now been shown that the former is a distinct disease (see p. 39). Tomato mosaic alone has been found not to cause "Stripe." Short descriptions will be given of tomato mosaic, and the viruses implicated in "Stripe."

Ordinary or mild tomato mosaic (tomato mosaic).

This is the most commonly occurring mosaic of tomatoes in the British Isles.

Material obtained from the Experimental Station nursery and several commercial nurseries was compared with authentic tobacco mosaic (tobacco mosaic No. 1, of Johnson), kindly supplied by Dr. Henderson Smith, of Rothamsted, with which it was found to be identical as regards filterability, resistance to aging, heat, and chemicals, and host range. The symptoms on a few plants will be described.

Tomato. The percentage infection is high (see Table 1) and the incubation period varies from five days in summer to three weeks in winter. Under spring and summer conditions a mild to moderably severe dark green mottle with slight leaf distortion and stunting results. (If the plant is growing well symptoms may become masked after the primary phase until the plant is "stopped," when developing side shoots are mottled and deformed). There is no necrosis and the fruit is not marked. In winter the mottle is absent but stunting and leaf distortion are more marked, the "fern leaf" type of symptom, and there is a development of anthocyanin in the stem.

Tobacco (*Nicotiana tabacum*). No necrotic local lesions are produced. Symptoms: a dark green mottle and a degree of stunting and leaf distortion dependant on the season. *Nicotiana glutinosa.* Necrotic local lesions develop, but infection is never systemic and the virus cannot be re-isolated.

Single virus "stripe" (glasshouse streak).

"Striped" tomato plants were obtained from over as wide an area as possible and inoculations made to tomato and tobacco plants. The same virus was found to be present in every case either alone or mixed with tomato mosaic or more rarely with spotted wilt. A selection of ten strains of this virus (from different parts of England, Ireland, and Wales) was made and they were compared with each other and tomato mosaic.

As regards filterability, aging in vitro, and resistance to heat and chemicals the virus was found to be identical with tomato mosaic. The host range was also similar, and though on some hosts the symptoms were identical with those of tomato mosaic on others the two viruses were readily differentiated.

Tomato. The symptoms agree with those given for "Stripe" above, but in addition there may be a mottle, identical with tomato mosaic mottle, which develops either before, at the same time, or after the stripe symptoms, and which is frequently the only symptom under the prevailing experimental conditions (see Table 1).

Tobacco (*Nicotiana tabacum*). Necrotic local lesions always develop and may be the only symptom. Systemic infection may follow at once when a necrosis spreads rapidly down the petioles of the inoculated leaves into the young leaves. The plant is often killed, but if it survives growth is very slow, the leaves are mottled and show necrotic lesions between the veins. Plants showing only local lesions grow normally and no virus can be isolated from the upper parts. Later, usually two or three weeks after inoculation, a number of these plants begin to show an internal necrosis of the stem which spreads rapidly upwards causing a severe vein necrosis. The virus can then be isolated unchanged.

Nicotiana glutinosa. Symptoms as tomato mosaic.

Table 1.

Summary of Tomato Inoculations made over the same period.

Virus.	No. Plants Inoculated.	No. Infected.	Mosaic only.	Leaf and Stem Lesions (Stripe)
Tomato Mosaic ...	71 ...	62 ...	62 ...	0
Single virus stripe (glasshouse streak)	79 ...	79 ...	57 ...	22
Mixed virus stripe (streak)	58 ...	58 ...	0 ...	58

In some respects the viruses of tomato mosaic and glasshouse streak are closely related. It is a possibility that the latter is only a more virulent strain of the former or else a mixed virus, but no observations in support of either view have been made. One strain of tomato mosaic has been under constant observation during eighteen months and several other strains shorter periods; in no case has a variant arisen. (It was stated in the 17th Annual Report, p. 43, that some plants affected with mild mosaic developed "Stripe." This statement was due to the failure to appreciate the fact that the only symptom of glasshouse streak on tomato may be a mottle indistinguishable from that caused by tomato mosaic).

Tomato mosaic has not produced a case of "Stripe," while glasshouse streak inoculations have given a mixture of mottled and striped plants (see Table 1), further inoculations from which have given rise to striped and mottled plants irrespective of the type of plant from which the inoculation was taken.

The two viruses retain their special properties when mixed. In a commercial crop there is frequently a mixed infection when first inoculations from plants naturally infected to tobacco plants show local lesions followed by typical tomato mosaic symptoms, while subsequent inoculations from the young mottled tobacco leaves to further tobacco plants show no lesions. If a series is continued in tomato from such a naturally infected plant then subinoculations to tobacco continue to show lesions. Tobacco is able to filter out the "Stripe" virus.

Mixed virus "stripe" (Streak).

This type of "Stripe" is a rare occurrence in glasshouses in this country. It has been observed and distinguished as "peppery stripe," but the symptoms are very similar to the single virus "Stripe." The disease is typically the result of a mixed infection of tomato mosaic and potato mosaic and can be readily synthesised and analysed. By inoculation of *Nicotiana glutinosa* the potato mosaic component can be isolated as it alone becomes systemic. Streak does differ in certain respects from glasshouse streak as was pointed out in the 17th Annual Report, p. 42.

Table 2 (page 46) compares tomato mosaic, single virus "Stripe" (glasshouse streak), mixed virus "stripe" (streak) and spotted wilt.

Summary.

"Stripe" disease of tomatoes may be due to several causes: a bacterium ("*Stripe*"), a single virus (*glasshouse streak*), or a mixed virus (*streak*). The viruses implicated are described.

Tomato mosaic has been identified with true tobacco mosaic and shown not to be involved in most of the "Stripe" disease of this country.

A comparison of the above viruses with spotted wilt has been made.

3. Physiological Investigations of Mosaic Diseases of the Tomato.

W. H. Read.

The examination of the carbohydrate and nitrogen metabolisms of tomato plants inoculated with aucuba mosaic disease has been continued and the previous findings, described in the Annual Report for last year, have been confirmed. Results were obtained by the use of a large number of healthy plants and a similar number of plants of the same sowing

Table 2.

Comparison of Tomato Mosaic, Glasshouse Streak, Streak, and Spotted Wilt.

	Filterability.	Longivity in vitro.	Differential Hosts. Tomato (*Lycopersicum esculentum*).	Tobacco (*Nicotiana tabacum*).	*N. glutinosa*.	*Datura Stramonium*.
Tomato Mosaic	Can be filtered through Pasteur-Chamberland filters.	Several years.	Mottle, slight to severe leaf distortion, no necrosis. Fruit not marked.	Mottle and leaf distortion, no local lesions.	Necrotic local lesions, no systemic infection.	
Glasshouse Streak (single virus)	,, ,,	,, ,,	Mottle and/or necrotic stripes on stem and petioles with necrotic areas on leaves. Fruit marked.	Necrotic local lesions, systemic necrosis and mottle.	,, ,, ,,	
Streak ... (mixed virus)	,, ,,	Six months (after which potato mosaic component inactive).	As glasshouse streak, but mottle only rare. Fruit marked.	——	Potato mosaic component becomes systemic and can be recovered.	
Spotted Wilt ...	Cannot be filtered.	A few hours.	Bronzing of leaves, stunting, yellow mottle (necrosis of stem and petioles rare). Fruit marked.	Large zoned necrotic local lesions, severe systemic necrosis.	Large necrotic local lesions, systemic infection usually kills plant.	Local lesions in form of rings, systemic infection.

inoculated by friction with a bruised leaf of a plant infected with a standard strain of aucuba mosaic. The two lots of plants were given the same cultural treatment and conditions.

Samples of at least ten plants of each series were taken at sunset and the same number placed in the dark twelve hours before they were sampled in the morning. When inoculated the plants were about 6 inches in height; the experiment lasted six weeks from the time of inoculation.

The material was prepared for analysis by cutting off the plants immediately above the cotyledons, rapidly weighing to obtain the fresh weight, and killing by immersing for fifteen minutes in boiling 95% alcohol, to which was added a little calcium carbonate to neutralise the acids in the plants. The insoluble portion was then extracted with 95% alcohol for twelve hours in a soxhlet extractor, the extract being made up to a definite volume and analysed for reducing and non-reducing sugars, whilst the residue was dried to constant weight and aliquot portions used for the determination of starch by hydrolysis with taka-diastase.

The total nitrogen was determined by evaporating a definite volume of the extract to dryness in a kjeldahl digestion flask and adding the equivalent weight of dry material.

A brief outline of the results obtained is summarised as follows:—

Commencing about a week after inoculation on the inoculated plants sampled in the evening show a slight increase in reducing sugar compared with the healthy plants. Generally, however, whilst in the healthy plants there is an increase of reducing sugar after twelve hours darkness, the infected plants show a decrease. This same overnight difference is also found to occur in the amount of non-reducing sugars and in both cases extended throughout the remainder of the experiment.

The mean sugar contents of the two series showed little difference during the first three weeks of the experiment, which in some part may be attributable to the dull weather during this period, in consequence of which the infected plants merely showed leaf deformation with no yellow areas on the leaves.

Following this period, a spell of bright weather induced the typical yellowing of aucuba mosaic, which was accompanied by a remarkable increase in the amount of reducing sugars in the diseased plants sampled at night as compared with the healthy plants, whilst after twelve hours darkness the position was reversed. A similar effect, though not so pronounced, is obvious in the results obtained for the non-reducing sugars.

The amount of starch in the diseased plants was greater than in the controls during the dull period and commenced about a week after inoculation, but during the bright period there was very much less starch in the diseased plants than in the healthy plants.

No appreciable difference was found in the amounts of nitrogen in the two series of plants during a period of ten days after inoculation of the one series, but during the remainder of the time the diseased plants had slightly more nitrogen.

In addition to the above determinations the effect of aucuba mosaic on the carbohydrate and nitrogen metabolisms of tomato plants has been ascertained by analyses of samples of the laminæ and petioles of leaves taken at two hourly intervals over periods of twenty-four hours.

4. The Control of Cucumber Mildew.

O. B. Orchard.

Towards the end of the 1931 season, Shirlan paste and agral 1 was used on cucumbers as a control of the powdery mildew, *Erysiphe cichoracearum*. Although reasonable control of this disease was obtained, it was suspected that the continued use of this spray caused a hardening of the plants.

Experimental work on young plants early in the current year confirmed the hardening and slight scorching effect of Shirlan paste when mixed with agral 1, the spreading agent previously used in the control of tomato leaf mould. Another spreading agent, agral N., was obtained and thoroughly tested on young and old plants. This spreader has twice the wetting properties of agral 1, and does not cause scorching when mixed with Shirlan paste.

This spray has been extensively used on a number of commercial nurseries, and when used as soon as mildew first appeared has given satisfactory control. It is essential to spray at intervals of three to four days during the first month of mildew attack, followed with weekly applications. As much thinning of the oldest leaves as is practical should be carried out after each spraying. It is essential thoroughly to soak the foliage so that it drips, otherwise there is not sufficient spray on the leaves to penetrate the spore masses and destroy the spores.

3. Entomological Investigations.

1. Mushroom Pests.

E. R. Speyer.

In December, 1930, a ton of stable manure was divided into three equal parts, at the final turning, and the three heaps treated thus:—

Heap A. 2 lbs. flake naphthalene mixed in (6 lbs. per ton).

Heap B. 1 lb. flake naphthalene mixed in (3 lbs. per ton).

Heap C. Untreated.

Each heap was made into a bed covered with canvas upon a wooden frame in a small glasshouse.

On January 5th, 1931, the temperature of the beds was A. 80°F., B. 58°F., C. 65°F., and each was spawned with pure culture spawn. The beds were cased with ½ inch sterilised soil.

Record of the bed temperatures were taken daily until February 6th, and collections of insects and other animals appearing upon the beds were made at close intervals until March 18th.

(*a*) Observations upon the growth of the mushrooms.

Mycelium running well in all the beds January 21st.

Pinheads appeared upon all the beds March 6th.

Total crop March 14th to May 5th.

Bed A. 85 mushrooms—total weight 5 lbs. 12 ozs.

Bed B. 93 mushrooms—total weight 5 lbs. 10 ozs.

Bed C. 19 mushrooms—total weight 1 lb. 6 ozs.

(*b*) Temperature of the beds.

Bed A. attained a maximum temperature of 85°F. upon the eighth day after spawning, then gradually fell to 65°F. upon the thirty-second day after spawning.

Bed B. attained a maximum temperature of 73°F. upon the eighth day after spawning, then fell to 65°F. upon the thirty-second day after spawning.

Bed C. attained a maximum temperature of 90°F. upon the eighth day after spawning, then fell to 81°F. upon the thirty-second day after spawning.

It was doubtless mainly due to the high temperature of Bed C. that the subsequent crop was very poor and irregular. It is not safe to conclude that the addition of naphthalene to the manure of Beds A. and B. tended to moderate their temperature.

(*c*) Animal population of the beds.

The two winged flies (Diptera) undoubtedly constituted the major portion of the population in relation to variety of species. Five species of Sciarids and nine of Borborids were collected. Whereas the latter were most numerous upon the untreated Bed C. during the first few days after spawning (though they occurred plentifully upon Bed B. and less so on Bed A.), their number rapidly decreased, and became negligible at a period of four weeks after spawning. The Borborids are not likely to cause injury to the growth of mushrooms.

The larvæ of Sciarids, on the other hand, are known to cause serious damage. The most important of these found upon the beds was *Sciara auripila*, Winn.

Adults appeared first upon Bed A. upon the eighteenth day after spawning, and when the pin-heads showed upon the sixtieth day they were numerous upon all the beds.

It is highly probable that these flies did not originate in the manure, but were present in the glasshouse and laid their eggs in the casing soil at some period after the mycelium had started to run.

As far as actual numbers are concerned, spring-tails (Collembola) held first place, but only two species, *Xenylla mucronata*, Ax., and *Sinella cæca*, Schott, were present, the latter in small numbers.

Xenylla mucronata first occurred upon all the beds, in greatest numbers upon the untreated Bed C. upon the eighteenth day after spawning. On the following day they were present in millions, and continued thus until the pin-heads appeared. To these they did no injury, and suddenly diminished so as to become negligible.

No injurious mites (Acarina) were observed upon the beds, though forms which are semi-parasitic upon flies and beetles were present, especially upon the untreated Bed C.

Several species of predatory beetles (Coleoptera) were numerous during the first few days after spawning.

(*d*) Experiments on the control of pests.

For the control of spring-tails the following treatments were applied without any appreciable success:—

Spraying the beds with lysol up to a strength of 4 fluid ounces per gallon of water.

Spraying the beds with lypticide 1 part to 80 parts water.

Broadcasting upon the beds paradichlorbenzene at the rate of 2 ounces per square yard.

Broadcasting upon the beds naphthalene at the rate of 2 ounces per square yard.

Cyanide fumigation at the rate of 1 ounce sodium cyanide per 1,000 cubic feet space.

Conclusions.

Naphthalene was mixed into the manure primarily with the object of determing if infestation by injurious mites such as *Tyroglyphus* could be prevented. As these mites did not appear in the control bed this experiment failed to give the information required.

Sciarids and supposedly injurious insects, such as spring-tails, gained access to the beds after the latter were made up; for the prevention of these there is thus no object in treating the manure used to make up the beds.

Methods for the control of injurious animals in the beds need both revision and research.

2. The Red Spider Mite.

E. R. Speyer.

During late March numbers of tomato plants of varieties E.S.1, Smooth-leaved and Hairy-leaved Potentate in pots were infected with adult female Red Spider Mite (*Tetranychus telarius*, L.) taken from the foliage of Buddleya and arum respectively.

In April none of the plants which had been infected with Mite from Buddleya showed any signs of increase of the Mite upon them nor had the Mites fed upon the foliage.

The majority of plants infected with Mites from arum, however, became infested to a considerable degree and the Mites were both feeding and breeding upon the foliage.

In the case of cucumber plants similarly infected, both the Mites from Buddleya and arum quickly attacked the foliage and started breeding there.

There is thus some evidence that Mites which have previously been reared upon certain types of plant are unable to change their habit to feeding and breeding upon the tomato plant, while with other types of plant this is not the case.

Mites will feed and breed, on the other hand, upon the cucumber plant, irrespective of the plant upon which they have previously been reared.

In March tomato plants of the variety Kondine, in 9 inch pots, were watered with solutions of various salts, namely, manganese sulphate, sodium chloride, barium chloride, ferrous sulphate, magnesium sulphate and potassium iodide. The concentrations of each of these salts in the soil was varied from ·1% to ·2%. With the exception of the plants treated with potassium iodide, which died quickly in the case of the higher concentration, and were seriously injured with a concentration as low as ·025%, good growth was obtained in all cases, the foliage of the plants treated with sodium chloride being noticeably dark.

At the end of June a second series of plants was similarly treated with the salts mentioned, with the exception of potassium iodide, at a concentration of ·2% of each salt in the soil, each plant being watered with 7 grs. of each salt in 200 cc. water.

The plants were infected with Red Spider Mite taken from French beans, the object being to determine if the taking up of any of the salts in the plant-sap might have an effect upon the feeding and breeding of the Mite. Control plants were used as a check.

During July the increase and feeding of the Mite upon all the treated plants was noticeably greater than upon the untreated control plants. Towards the end of July all the plants received ½ ounce dried blood per pot. In August the control plants also showed a very heavy infestation equal to that of the treated plants.

It is therefore to be concluded that an unbalanced growth produced by the application of various salts to the soil is likely to increase, rather than decrease, infestations of Red Spider Mite.

3. Poison Baits for Woodlice.

E. R. Speyer.

It has been observed that the Woodlice commonly found in glasshouses are attracted to a considerable extent by dried blood, which is used as a top-dressing in the culture of cucumber and tomato plants. The Woodlice actually feed upon this manure.

Tests carried out, admittedly under unfavourable winter conditions, have shown that the best proportions in which to mix Paris green with dried blood as a poison bait is 1 part by weight Paris green and 56 parts by weight of dried blood.

As great a mortality amongst the Woodlice was recorded when the ingredients were mixed in the proportion of Paris green 1 to dried blood 28, but when only 1 part Paris green to 100 parts dried blood were used the mortality was considerably smaller.

During a warmer period of weather, a mixture of powdered potassium bichromate 1 part to 28 parts dried blood gave a very high mortality within a period of one week, but under less favourable conditions the results were most disappointing.

Barium chromate, barium bichromate, and oxalic acid mixed in similar proportions with dried blood were without effect upon the Woodlice.

Paris green is certainly the most effective poison as yet known for the destruction of these animals.

4. Thrips as Pests of Glasshouse Plants.

E. R. Speyer.

By means of breeding experiments the confusion which has arisen in the identity of three common species of Thrips has been finally unravelled.

The Rose Thrips, *Thrips fuscipennis*, Haliday, a pest of roses grown under glass and out-of-doors, and occasionally of the cucumber plant, is a species entirely distinct from *Thrips major*, Uzel, which was considered by Priesner as a variety of *T. fuscipennis*, Hal.

T. major, Uzel, occurs in the flowers of roses out-of-doors, and only rarely later in the summer under glass, together with *T. fuscipennis*, Hal.

The males of the two species are very different, but constant characters by which the females may be distinguished have now been found. These characters lie in the arrangement of bristles or setæ upon the abdomen, the structure of which has been almost entirely neglected by previous workers in the study of the Thysanoptera.

The Onion Thrips (*Thrips tabaci*, Lindeman) a general pest of the cucumber plant and also of carnation, cyclamen and arum flowers, is entirely parthenogenetic under glasshouse conditions and at least generally so out-of-doors, no males having as yet been known to occur in glasshouses.

Dr. G. Morrison has kindly sent to the Experimental Station specimens which are unquestionably males of this species, collected from out-door plants in Scotland. These males differ entirely from those of the two species previously mentioned and do not agree with the description of *T. tabaci*, Lind., given by Priesner. The latter description refers to the male of *T. fuscipennis*, Hal., and that given for *T. fuscipennis*, Hal., to the male of *T. major*, Uzel.

The accurate identification of various species of the Thysanoptera is becoming of increasing importance, owing to the relation which these insects have to certain forms of mosaic disease, which they have been proved to transmit from plant to plant.

As far, at least, as the species of the genus Thrips are concerned, the recording of differences in the abdominal structures, hitherto almost entirely neglected, are essential for the satisfactory determination of the species. In addition to the case of *T. fuscipennis*, Hal., and *T. major*, Uzel, already cited, two closely resemblant species inhabiting the flowers of dandelion, namely *T. physapus*, L., and *T. validus*, the females of which were previously separated upon very inconstant characters, are distinguished with the greatest ease by the structural characters of the abdomen, especially upon the ventral surface. On the other hand, it is highly probable that a large number of species described under different names will prove to be one and the same when these characters have been studied and recorded.

5. Experiments on the Control of Thrips.

E. R. Speyer.

Fumigation experiments were carried out in a chamber of 100 cubic feet capacity. Cut flowers of rose and other flowers, containing various species of Thysanoptera, were placed in vases over white paper upon a shelf in the chamber, and the fumigant used was distributed upon the floor of the chamber.

The fumigations extended over a period of fourteen hours, from late afternoon to the following morning. At the termination of each experiment, insects which had fallen upon the sheets of paper were carefully placed upon the petals of fresh flowers and kept under observation.

Any insects remaining in the flowers were similarly treated.

The following results were obtained, only the effects upon *Thrips fuscipennis*, Hal., and *T. major*, Uzel, being here recorded:—

	Fumigant.	Quantity.	Temp. °F.	Approx. % insects killed.
1.	Proprietary Insecticide containing naphthalene	1·5 oz.	60–76	75 males and females.
2.	Naphthalene Grade 16	1·0 oz.	58–78	100 males, 95 females.
3.	Naphthalene Powdered Nicotine	0·5 oz. 0–025 fl. oz.	58–69	95 males, 95 females.
4.	Naphthalene Powdered Nicotine Fusel Oil	0·4 oz. 0·05 fl. oz. 0·05 fl. oz.	58–82	95 males, 70 females, 70 larvæ.

The results show that naphthalene is a useful fumigant, but owing to the danger to the plant when comparatively large quantities have to be used, the addition of another substance having some effect upon Thrips is necessary, so that the quantity of naphthalene can be reduced. The addition of nicotine gives promise of good results, but the addition of fusel oil, which had quick effect under laboratory conditions, does not appear to improve the results.

Owing to the lateness of the season, only one fumigation could be carried out in a glasshouse of 1,500 cubic feet. In this, a dust containing 6 ounces naphthalene and ·3 fluid ounces nicotine was broadcast upon the floor of the house. The approximate percentages of *Thrips fuscipennis*, Hal., and *T. major*, Uzel, killed were males 100, females 80; only three larvæ were present in the flowers used, and these were all killed.

Using a similar preparation as a dust upon the onion Thrips in arum flowers, the insect was killed almost instantaneously, and with it good results have also been obtained in the control of the hot-house Thrips, *Heliothrips femoralis*, Rent., a pest of Crinum lilies and other hot-house plants.

6. Red Spider Mite Control.

O. B. Orchard and W. H. Read.

Many additional substances and insecticides have been tried as substitutes for the petroleum oil emulsion sprays now in general use for controlling the Red Spider Mite. Exhaustive tests of a sulphated crude oil derivative were made in commercial nurseries during the early part of the season when *œdema* often follows applications of petroleum oil emulsions unless great care is taken with cultural conditions. These

tests showed that this spray, whilst giving a control of the Mite with a lower oil concentration at the effective spray strength, caused slightly more *œdema* than several of the recently introduced petroleum oil emulsions and in consequence its use cannot be recommended.

A point of importance in using petroleum oil emulsions was noted at one nursery where there was difficulty in killing the Mite. Although only one instance of the particular trouble has been brought to our notice, the same cause of ineffective control may contribute in cases of severe *œdema* on tomatoes after spraying. When the stock emulsion was diluted in the spraying tank with water taken from the nursery supply and agitated to ensure proper mixing much scum was produced, containing about 65% by weight of the oil. As the water in this scum was present as drops suspended in the oil, which is the reverse of the normal emulsion, further agitation tended to increase the amount of scum.

The trouble was traced to the presence of suspended and colloidal matter in the water used for diluting the emulsion, owing to the use of a water-softening composition. This compound although added in minute quantities to the main water tank had by its action on the rust in the pipes liberated solid material. This partially destroyed the diluted emulsion, produced the scum, and caused the trouble.

7. Cucumber Root Fly Larvæ.

Plastociara perniciosa, Edw., & *Pynxia scabici*, Hopk.

O. B. Orchard.

This pest again caused serious damage on many nurseries during the early part of the season. Serious losses occurred both in the pot stages and after planting out in borders.

Numerous chemical substances were tried in an attempt to destroy the maggots, for, although a solution of mercuric chloride at a strength of 0·1% had previously given satisfactory control when used on old plants in borders, it was found to harden young plants in pots.

Nicotine at a strength of $\frac{1}{1000}$ gives a satisfactory control of the maggot, but no drench controls this pest without several applications. Frequent applications of nicotine soon cause the plants to turn yellow, but it was found that when mixed with a sulphonated oil product, the drench can be applied as often as necessary without damage to the plants. Cucumber plants were treated both in the pots and borders and at intervals of one week throughout the season. No ill effect of any kind was noticed.

Early in March, when a severe attack occurred in one nursery, three houses were treated, the attack was stopped and there was no further loss of plants.

Later in the season, the drench was used successfully on a number of nurseries and many growers expressed the opinion that the cucumber plants benefited from the use of the drench. During the application both pots and borders must be thoroughly soaked and in severe cases a second application is necessary after an interval of one week.

4. Chemical Investigations.

The work on the nitrate-nitrogen in a tomato soil and in the drainage from it was continued on lines similar to those described in the last Report. To reduce complications it was decided to keep the plot fallow and unmanured.

Determinations of the nitrate in the soil were made weekly from March to September. The plot was watered as though plants were growing in it and any drainage which resulted was measured and examined for nitrate and ammoniacal nitrogen.

The values for the nitrates in the soil are shown graphically in Fig. 1. It will be seen that the fluctuations follow the same

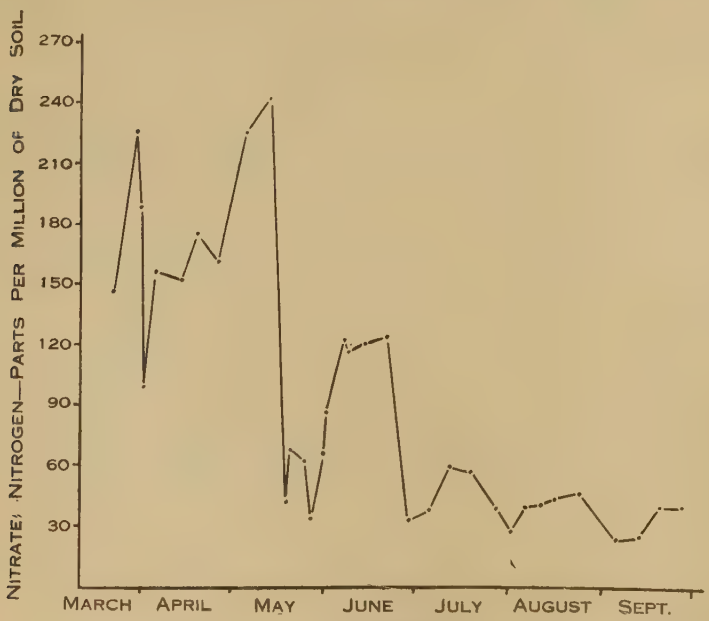


FIGURE 1.

trend as that already recorded for other plots on the nursery. As formerly, the amounts of ammoniacal nitrogen in this soil were negligible. On a number of occasions the samples were tested for nitrite-nitrogen by the Griess-Ilosvay reagent but never more than the merest traces were found to be present.

Table 1 gives the values for the total volume of the drainage, the nitrate-nitrogen and amoniacal nitrogen contents. It will be seen that the total amount of nitrogen in the

Table 1.

Date.	Volume (Litres).	Nitrate-nitrogen in Drainage—gm. per litre.	Total Nitrate-nitrogen (gm).	Total Ammoniacal-nitrogen (gm.).
May 19	53·65	·1299	6·971	·05673
„ 25	84·1	·1913	16·09	·06341
June 1	47·85	·1381	6·612	·06627
„ 8	33·36	·1338	4·462	·04187
„ 15	81·21	·1379	11·20	·1125
„ 17	100·1	·1283	12·86	·03651
„ 22	119·0	·1133	13·48	·10794
„ 29	102·9	·1049	10·79	·08974
July 6	116·0	·09128	10·59	·11347
„ 13	121·8	·09251	11·27	·00536
„ 20	116·0	·08056	9·346	·1155
„ 27	100·1	·07199	7·207	·05002
Aug. 10	116·0	·0602	6·984	·03858
„ 18	81·21	·05201	4·225	·04345
„ 25	101·5	·05451	5·533	·03228
Sept. 6	111·6	·05023	5·604	·02209
„ 21	58·01	·04447	2·58	·03405
Total	1544·		145·8	1·0298

ammoniacal form is very low and for the whole year is less than 1% of the nitrate-nitrogen. During 1931 the proportion was higher. It is interesting to note that the total nitrate-nitrogen (145·8 gm.) this year is considerably higher than that (32 gm.) found last year when the plot was cropped and manured. The fluctuations in the amount of the nitrate-nitrogen in the drainage are shown graphically in Fig. 2. The total water applied to the plot corresponds to 713,700 gallons per acre and it is estimated that water not accounted for in the drainage corresponds to 525,220 gallons per acre. It may be noted that the proportion which drained through under these (fallow and unmanured) conditions was slightly less than that which drained through last year. So that under these conditions about 525,000 gallons of water evaporated per acre during the season. This, of course, must be in considerable excess of what evaporates normally from a soil carrying a tomato crop.

The question again arises as to the fate of the nitrate-nitrogen which disappears when water is applied to the soil. Some slight progress has been made in an attempt to settle

this question and two points have been examined in this connection. In the first place the effect of steaming the soil on the disappearance has been determined. One of two adjacent plots was steamed and nitrate determinations were carried out for some weeks before and after the first watering.

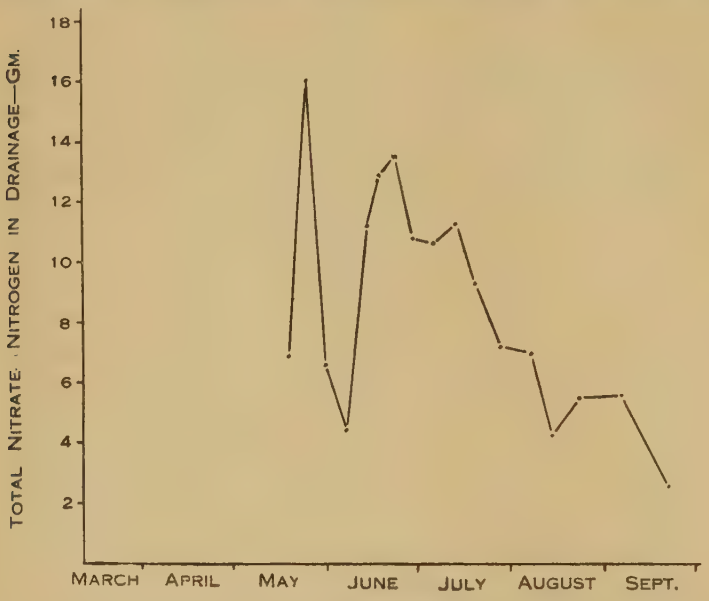


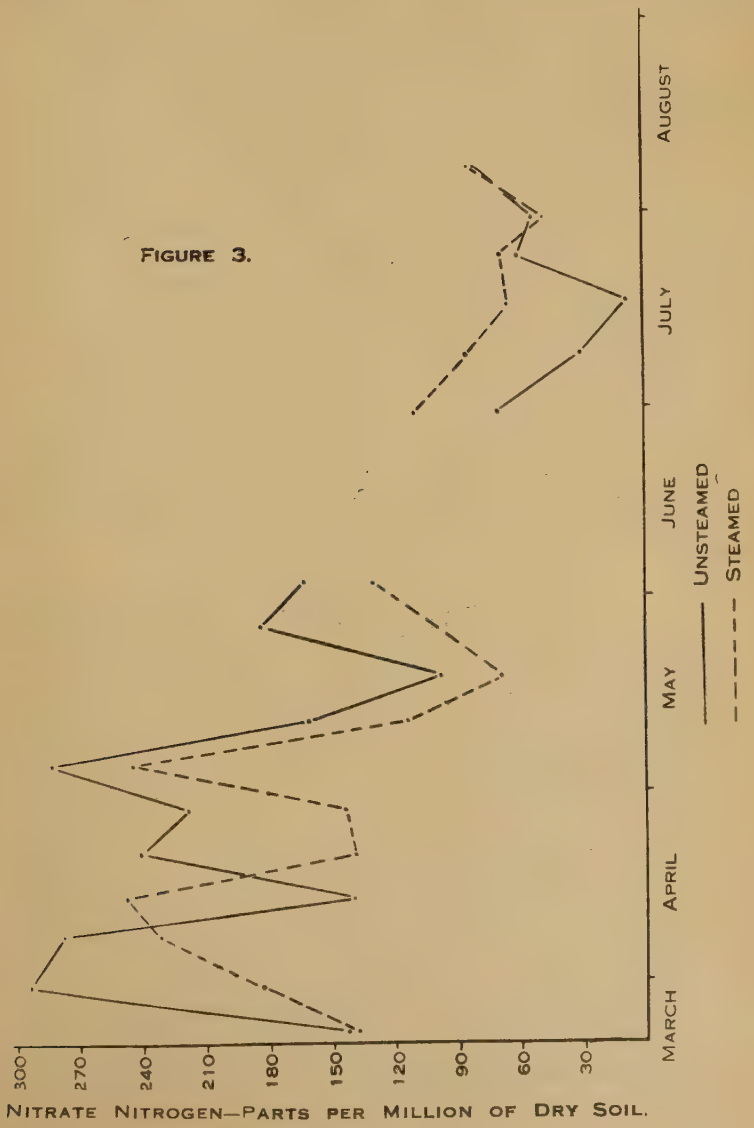
FIGURE 2.

The curves given in Fig. 3 show how the values fluctuated under the two sets of conditions. It will be seen that there is not a great deal of difference in the two cases. These results were confirmed in several series of pot experiments where steamed and unsteamed soils, some kept dry and some kept wet, were examined. It was always found that the fluctuations in steamed soil were similar to those in the unsteamed soil. The only apparent difference was that in wet soils which were allowed to dry out slowly the accumulation of nitrate during drying were more rapid in the steamed soils. So that the factor responsible for the disappearance of nitrate operates in steamed soil.

Secondly, the effect of wetting the soil as against watering to cause leaching has been examined. Twice the soil in the concrete tank has been watered so that there was no drainage; it was wetted thoroughly, but, so that there was no possibility of nitrate being washed out. The amount of nitrate in the top 6 inches of soil on one occasion fell from 188 to 100 p.p.m.,

and on another from 64 to 35 p.p.m. These results were confirmed in several pot experiments. Even when insufficient water was added to saturate the whole of the soil the nitrate in the surface always fell; there was the possibility that nitrates were washed down into the lower layers, and an attempt was made to measure this effect in the concrete tank.

FIGURE 3.



The results of analyses of depth sampling, however, were very erratic on each of four occasions and no reliable information was obtained.

There remains, now, the question of what this nitrate disappearance signifies and whether it is to be regarded as an actual loss of nitrogen from the soil. Both last year and this year the total nitrogen in the drainage is considerably less than the amount of nitrogen which disappears in the nitrate fall which follows watering. If this nitrogen is actually lost it appears that it must be evolved as nitrogen gas. So far no gasometric studies have been made but evidence of an indirect nature is available. A balance sheet for nitrogen has been made for two of the experimental plots. In the case of House 7, Plot 8, which has been manured and cropped continuously from 1923 to date, it was assumed that the tomato crops produced there would take up nitrogen at the same rate as crops already analysed from some of the other plots. On this assumption, and taking into account the fertilisers added and the nitrogen in the soil in 1923 and now, it appears that there has been an actual gain of nitrogen to the amount of about 360 lbs. of nitrogen per acre. This figure cannot be regarded as anything but approximate, but it is considered that it is likely to err on the low side. Similar examination of the data for the soil in the lysimeter tank for the past two years also gives an indication of a gain in nitrogen. At the same time it must be pointed out that balance sheets based on similar data for some of the plots in the older houses show a nett *loss* of nitrogen.

It is possible that the compounds resulting from denitrification are held in the soil for the time, and later on they became available for nitrification and nitrates result. This view is in accord with the suggestion made by Russell and Richards that a nitrate immobiliser is at work. Under certain conditions it takes up nitrate (causing the apparent denitrification) and under different conditions liberates them, tending to cause an accumulation of nitrates. Under our conditions, there appear to be two factors which direct the activities of this agent. They are nitrates and water content of the soil. Both or one of these may influence its activities. On the denitrifying side it is possible that increase of water in the soil increases the activity while decrease in water favours the reverse process. If we regard the denitrification activities alone it may be that nitrates actually reduce the activity of such an agent; that is to say an accumulation of nitrates reduces its activity to a minimum. Anything which tends to reduce the nitrate concentration (watering or a sudden intake of nitrate by plants) stimulates the activity and denitrification

proceeds, until some sort of equilibrium is reached. Then conditions alter and presumably normal nitrification starts again and the accumulation of nitrates tends to proceed.

Whatever the explanation of these phenomena may be it is quite likely that, from an economic point of view, the denitrification which occurs during and after watering is desirable. All the previous work done on these soils suggests that the loss of nitrogen in drainage is highest when the nitrate content of the soil is highest. By reducing the amount of nitrates in the soil denitrification tends to reduce the losses in the drainage and unless there is an evolution of gaseous nitrogen this tendency means an economy of nitrogen.

5. Physiological Investigations.

1. The Effect of Air Temperature on the Tomato.

O. B. Orchard.

During the current year, it was considered advisable to check the previous work on the effect of air temperatures on the crop yield of tomatoes. For this purpose House 6, which is divided into six chambers, was used. The heating system of each chamber was thermostatically controlled to maintain minimum night air temperature of 67°F., 65°F., 65°F., 55°F., 55°F., and 50°F. in chambers 1—6 respectively. These temperatures were maintained from February 26th, the date of planting, until May 9th. The accompanying Table shows the weight of fruit obtained, each chamber containing fifty-six plants of the variety E.S.1.

Chamber.	Mean Air Night Temp.	Lbs. per Plant to end of June.	Total Lbs. per Plant.	Total Tons per Acre.
1	67°F.	1·33	6·84	51·98
2	65°F.	2·49	8·09	61·48
3	65°F.	2·49	8·26	62·78
4	55°F.	0·26	6·99	53·12
5	55°F.	0·27	7·40	56·24
6	50°F.	0·11	7·07	53·72

This experiment confirms the work of previous years in these chambers, and suggested that the optimum temperature for the tomato crop is from 63°F. to 65°F.

2. Physiological Investigations of the Tomato Plant.

B. D. Bolas and R. Melville.

During the summer of 1932 methods were evolved which enabled the influence of a number of factors, light and temperature in particular, to be studied in relation to the growth and metabolism of seedling tomato plants growing under normal cultural conditions.

Experiments carried out during the autumn of 1932 and during the winter 1932-3 have been divided into three main groups, namely, the influence of light and temperature on the

assimilation rate, the influence of temperature on the rate of respiration and translocation, and the influence of various other factors on these processes.

A number of interesting results have been obtained although a considerable amount of further work will be necessary to provide final confirmation. The gain in weight of the plant during even a dull winter day has been found to be as high as 7·71%, but it would appear that most of this gain due to assimilation is lost owing to respiration during the long night, thus the nett gain in this particular case was only of the order of 2% in twenty-four hours.

The experiments also suggest that while a very moderate temperature is sufficient to enable assimilation to proceed at such a rate that it is limited by light intensity, a higher temperature may not only slow down the assimilation rate but will tend to increase respiration losses. An excessive temperature will in addition seriously affect the type of plant produced for various other reasons.

In all cases light intensity was determined by making frequent observation by means of the Holophane "Lumeter" during the experimental assimilation period of seven hours. From these observations the total illumination was calculated in terms of foot candle hours. Mean temperatures were obtained from thermograph records during the same period.

In the respiration and translocation experiments a standard period of seventeen hours was taken and thermograph records were used in the same way as in the assimilation experiments. Some of the results are given below.

Assimilation Experiments.

Plants used were of the variety E.S. 1. They were about 6 inches high and had about eight expanded leaves. All assimilation rates were determined over a seven hour period.

Date.	Total Light.	Mean Temp. °F.	% Gain in dry wt. of whole plant.	n.	P.	t.
22/8/32	3838	67·0	21·95	18	0·01	2·85
31/8/32	5453	73·0	16·02	12	0·10–0·05	2·01
19/9/32	1895	58·8	12·02	18	0·01	3·38
21/9/32	5687	67·7	11·15	17	0·01	3·72
7/10/32	1350	69·0	10·71	9	0·01	4·37
13/10/32	2996	70·0	17·05	9	0·01	3·96
24/10/32	1205	66·1	8·81	5	0·02–0·05	3·34
2/11/32	1106	64·1	8·03	5	0·10–0·05	2·23
14/11/32	313	61·6	0·89	14	0·70–0·60	0·47
5/12/32	677	64·4	6·71	22	0·05	2·60
19/1/33	398	62·5	10·80	23	0·01	7·29

Respiration Experiments.

Plants used were similar to those for assimilation experiments. All respiration rates were determined in darkness over a period of seventeen hours.

Date.	Mean Temp. °F.	% Loss in dry wt. of whole plant.	n.	P.	t.
24/8/32	63·0	4·64	12	0·40	0·89
19/9/32	49·8	2·92	18	0·40–0·50	0·70
13/10/32	61·0	5·85	9	0·01	3·88
11/2/33	52·6	4·83	11	0·02–0·05	2·30

The number of "degrees of freedom" in each experiment is given in column "n." The figures in columns "P" and "t" are calculated according to the methods given in Fisher's "Statistical Methods for Research Workers." In these experiments a value of "P" of 0·05 or less is taken as indicating a significant result. Where "P" is less than 0·01 it is given as 0·01 in the Table.

An interesting point arises in that the nett gain of the plant in twenty-four hours may be taken as corresponding to assimilation gain minus respiration loss. Correcting these figures on the basis of a mean loss of 4·56% during the night we have:—

Date.	Light.	Temp.	Nett gain % in dry wt. in 24 hours.
22/8/32	3838	67·0	17·39
31/8/32	5453	73·0	11·46
19/9/32	1895	58·8	7·46
21/9/32	5687	67·7	6·59
7/10/32	1360	69·0	6·15
13/10/32	2996	70·0	12·49
24/10/32	1205	66·1	4·25
22/11/32	1106	64·1	3·47
14/11/32	313	61·6	3·67
5/12/32	677	64·4	2·15
19/1/33	398	62·5	6·24

It has been shown by Professor V. H. Blackman that the increase in dry weight of the plant often obeys the compound interest law during part of its growth period. Thus the dry weight of the plant at time T is given by the formula $W_T = W_0 e^{KT}$ where W_T equals weight at time T and W_0 equals weight at the beginning of the experiment. K represents the "growth rate" of the plant or "efficiency index."

Thus if K remains constant a plant which gains 17·39% in dry weight in a twenty-four hour day will have multiplied its weight by 9·46 in fourteen days. A plant which gains 6·24% in twenty-four hours will only have multiplied its

weight by 2·29. It is not suggested that K will in practice remain constant, but the figures emphasize the fact that a small increase in the growth rate of the plant over a long period will have a marked effect on its size.

It will be observed from the determinations of assimilation rate that the relation between the assimilation rate, light and temperature is by no means simple. This may in part be due to the temperature coefficient of assimilation being relatively low while that of respiration in the presence of sufficient respirable material is probably relatively high; that is to say respiration increases rapidly with temperature. Thus a very small excess of temperature above that necessary to enable assimilation to proceed at its maximum rate as determined by the illumination will result in larger respiration losses. These may be serious in winter when the light intensity is low.

Indications have been obtained from the above and other experiments of a seasonal variation in the assimilatory efficiency of the plant and of an injurious effect due to the relatively long winter night. Further work is in progress.

3. The Use of Electric Light in Propagating Houses.

W. F. Bewley and W. H. Read.

Further experiments in continuation of those described in last year's Report have been carried out to study the effect of electric light on seedlings during the winter. In addition to the normal type of gas-filled incandescent filament lamp various discharge tubes have been tried. The previous results having shown that illumination for a period of six hours yielded the best results the period from 4.0 p.m. to 10.0 p.m. was again adopted.

In the first series of experiments the sources of illumination were the 500 watt gas filled lamp fitted with a white enamelled reflector, a sodium vapour discharges tube kindly loaned by the Research Laboratories of the General Electric Co., Ltd., and four Neon discharge tubes kindly loaned by Messrs. Claude Neon, Ltd. The sodium discharge tube was fitted with a polished aluminium reflector and suspended 18 inches above the bench. The Neon tubes were also fitted with polished aluminium reflectors, two being suspended 18 inches from the bench and the others at a distance of 30 inches. The gas-filled 500 watt lamp was placed 2 feet from the bench.

Experiments to find the effect of illumination by these lamps on tomato and lettuce seedlings and the propagation of cucumbers, French beans, tomatoes, radish, turnips and sweet peas were commenced on November 21st. Thermometers placed on the bench below the lamps showed the following temperature rises due to heat emitted from the lamps:— 500 watt gas-filled lamp 16°F., sodium vapour lamp 5°F., low Neon tubes 2°F. and high Neon tubes ½°F.

It was found that the germination of the seeds was hastened considerably from the heat radiated from the lamps the extent of this hastening being relative to the rises in temperature shown above. When growth commenced little benefit to any of the plants was observed with the Neon lamps, and whilst the seedlings benefited to some extent from illumination from both the 500 watt gas-filled and sodium vapour lamps, the plants were weak and drawn in either case as compared with control plants from seed sown at the same time. The cucumber plants showed the greatest benefit from the illumination and this was most pronounced in the series below the 500 watt lamp.

It is admitted that the air temperatures in the house where the tests were conducted were too low for cucumber culture under normal conditions, and since the remarkable difference between the plants illuminated by the 500 watt lamp and the controls might have been due to the heat obtained from the lamps a second series of tests were made in which one lot of plants was subjected for six hours at night to the radiant heat from a small electric "bowl" radiator suspended above them and another lot treated for the same period with radiant heat from a "Dulrae" panel kindly supplied by Messrs. Crittall.

In neither case did the plants show benefit from this treatment and the increased growth promoted by the 500 watt lamp must have been due to the light emitted.

APPENDIX A.

Manurial Treatment in the Tomato Experiments.

(1) Lime.

All Houses except No. 1, 11 and 12 received ground caustic lime at the rate of 2 tons per acre.

(2) Stable Manure.

Houses 1, 2, 7, 8, 10, 11 and 12 received 15 tons per acre.

(3) Base-dressing.

Houses 3, 4, 5, 6 and 9 were steamed, and 1, 5, 6 and 9 received 10 cwts. of sulphate of potash per acre.

House 2 received ¾-lb. per sq. yd. of the following mixture:—

1 part bone meal.
1 part bone flour.
1 part hoof and horn.
1 part sulphate of potash.

Houses 7, 8, 10, 11 and 12 received ¾-lb. per sq. yd. of the following mixture:—

1 part bone meal.
1 part bone flour.
1 part sulphate of potash.

(4) Top-dressing.

Houses 2, and 5 to 12, received 2-ozs. per sq. yd. of the following mixture every 14 days at discretion:—

3 parts sulphate of ammonia.
2 parts dried blood.
7 parts 30% superphosphate.
5 parts pure dissolved bones.
½ part bone flour.
2½ parts sulphate of potash.

This gave 5% ammonia, 24% total phosphates, 12% soluble phosphates, and 7% potash on examination.

Appendix B.

Manures applied to Plots 1-3, and 14-16 in Tomato Houses 3 and 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				† Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super-phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	-
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
14	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2	0.2
15	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
16	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

† The Top-dressing was applied in eight equal instalments.

Manurial Treatment in House 3, and Plots 4-13 in House 4.

FERTILISERS IN POUNDS PER SQUARE YARD.

House.	Plot.	Base.					Top-dressing.					
		Bone Flour.	Sulphate of Potash.	Cyanamide.	Hoof and Horn.	Shoddy.	Sulph. of Ammonia.	Nitrate of Soda.	Nitrate of Lime.	Dried Blood.	Peruvian Guano.	Fish Manure.
3	1 5 10 14	0.25	0.25	—	—	—	0.48	—	—	—	—	—
3	2 6 9 13	0.25	0.25	—	—	—	—	0.65	—	—	—	—
3	4 8 11 15	0.25	0.25	0.64	—	—	—	—	—	—	—	—
3	3 7 12 16	0.25	0.25	—	—	—	—	—	0.93	—	—	—
4	7 12	0.25	0.25	—	—	—	—	—	—	0.86	—	—
4	4 10	0.25	0.25	—	0.86	—	—	—	—	—	—	—
4	5 9	0.25	0.25	—	—	—	—	—	—	—	0.80	—
4	8 11	0.25	0.25	—	—	—	—	—	—	—	—	1.18
4	6 13	0.25	0.25	—	—	0.86	—	—	—	—	—	—

Appendix C.

Dates of Cultural Operations during 1931—1932.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Cucumbers	Dec. 7 1931	——	Dec 15 1931	Feb. 1 1932	Mar. 1 1932	Mar. 8 1932	Mar. 11 1932	Sept. 9 1932
Tomatoes	Dec. 7 1931	Dec. 28 1931	——	Feb. 26 1932	——	May 10 1932	May 20 1932	Oct. 27 1932

Month.	Air Temperatures						Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Barometer
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Precipitation	No. of Days P'p'tn.	Greatest Fall				Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total No. of Hrs.	Daily Average.	
	Max.	Min.	Tem.	Date	Tem.	Date		Tem.	Date			Amt.	Date	1 ft.	2 ft.							
	°F.	°F.	°F.		°F.		°F.	°F.		Ins.		Ins.		°F.	°F.	°F.	°F		°F.			Ins.
January	48.3	34.2	56	13th	23.5	31st	32.5	22.0	31st	1.24	8	.37	16th	42.0	43.3	41.5	0.5	94.6	40.0	38.7	1.2	30.267
February	44.7	30.4	52	3rd	22.0	7th	29.7	22.0	6th, 7th	0.11	6	.04	23rd	38.7	40.4	37.9	0.8	93.5	36 0	66.4	2.3	30.447
March	50.8	29.9	59	31st	18.0	12th	29.4	18.5	12th	1.33	12	.38	22nd	38.9	40.1	43.6	1.6	87.9	39 8	133.6	4.3	29.962
April	54.0	36.9	66	30th	30.0	8th	35.1	27.0	8th, 12th	2.35	19	.26	16th	45.9	46.0	47.7	1.8	87.3	43.8	122.7	4.1	29.743
May	61.6	42.8	77	19th, 20th	31.0	5th	40.9	29.0	5th	2.91	17	.83	9th	53.5	52.6	55.2	1.8	88.1	51.4	127.8	4.7	29.797
June	70.4	48.7	85	2nd	41.0	5th, 9th	46.5	37.0	5th	0.87	6	.78	30th	61.1	59.7	62.1	2.5	85.2	57.5	218.9	7.3	30.044
July	73.6	52.1	85	9th, 10th	40.0	24th	50.9	40.0	18th, 24th	1.82	15	.65	25th	64.1	62.9	65.9	2.4	85.5	61.4	169.4	5.4	29.857
August	77.0	54.1	99	19th	42.0	31st	52.4	40.0	31st	1.89	9	.64	1st	65.6	64.7	68.1	2.0	88.2	64 4	233.2	7.5	29.758
September	66.5	48.1	78	8th	39.0	21st	46.0	35.0	20th, 21st, 26th	1.94	18	.50	2nd	59.0	60.0	60.6	1.1	93.1	58.5	103.0	3.4	29.935
October	56.7	40.4	65	2nd	31.0	28th, 31st	37.5	28.0	28th	4.29	23	.75	20th	50.4	51.8	52.5	0.9	93.3	50.6	91.7	2 9	29 715
November	50.1	38.7	60	27th	29.5	21st	37.2	26.0	21st	1.47	18	.32	22nd	46.4	47.8	46.0	0.6	94.4	46.1	47.2	1.5	30.099
December	47.7	35.4	55	18th, 19th	25.5	5th	33.0	24.0	4th, 5th	0.50	4	.18	31st	41.4	43.4	41.7	0.4	97 0	40.7	40.8	1.3	30.022

Total rain for year, 20.72 ins. No. of days precipitation, 155. Total bright sunshine for year, 1393.4 hours.

DIAGRAM SHOWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1932.